

# Assessment of the Output of Local Engineering Education Programs in Meeting the Needs of the Private Sector for Economies in Transition: The Palestinian Territories Case\*

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*This paper presents the methodology and the results of a study which assessed the output of local engineering education systems for an economy in transition. The paper considers the case of engineering education in the Palestinian Territories, which are evolving towards becoming an independent entity. The assessment was performed from the viewpoint of private sector customers in order to examine to what degree local engineering education programs were meeting their expectations. The approach investigated the areas of strengths and weaknesses of the local universities' engineering graduates compared to their counterparts in universities abroad. The results indicated that local university graduates possessed overall competence and were strong in many aspects, such as theoretical and analytical abilities and computing skills. However, there were weaknesses in their applied skills and practical training, technical writing and scientific research capabilities, and English language skills. The results were utilized to establish the outcomes that engineers should achieve. One recommendation is modifying the curricula by accommodating specific topics and courses and enhancing the students' abilities and skills that are identified as needing to be upgraded. Another recommendation is increasing the interaction between the private sector and the universities and establishing university–industry partnership programs.*

## INTRODUCTION

ENGINEERING EDUCATION plays a significant role in development through education and training of technical human resources. Engineering educational systems in local universities in countries whose economies are classified as 'economies in transition' are usually geared towards satisfying developmental and reconstruction needs, as is the case in the Palestinian Territories. The demand for skilled and well-trained human resources has been significantly increasing since the early 1990s in particular, in the wake of signing the Oslo agreement and the advent of the Palestinian National Authority (PNA) in 1993 and its taking power in the West Bank and the Gaza Strip, which had been occupied by Israel since 1967. Intensive development and reconstruction efforts have been initiated since then, with the assistance of the international community and private investors, especially in the infrastructure, construction, and industry sectors.

This paper presents a methodological approach which was followed in order to assess the degree of success of local engineering education programs in meeting the needs of the market from the private

sector's perspective. The paper illustrates the application of such assessment methodology to examine the output quality of Palestinian engineering education systems, and suggests, on the basis of that, sound recommendations to improve engineering education.

There are currently ten universities in the Palestinian Territories. Five of them award degrees in engineering. The Ministry of Education and Higher Education (MEHE) regulates and monitors the quality of education in these universities. Engineering education systems were established in the Palestinian universities in the late 1970s in order to satisfy the then gradually increasing demand of the private and public sectors for qualified engineers. Despite the modest development needs at that time, due to the restriction imposed by the Israeli occupation, these systems resulted in the graduation of hundreds of engineering graduates who were employed in the local and regional markets.

The total area of the West Bank and Gaza Strip is 5,950 square kilometers, while the population was estimated at 3.3 million in 2001. The per capita GDP in the Palestinian Territories was about 1,200 USD in 2001. The number of registered engineers

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in the West Bank and Gaza strip topped 9,500 in 2001.

The paper illustrates the research objectives first and then presents the development and status of engineering education in the Palestinian Territories. After that, the methodological approach is outlined. The private sector viewpoint is presented and analyzed, and is then followed by a brief presentation of academic opinion. Finally, the paper ends with conclusions and recommendations.

### RESEARCH OBJECTIVES

The paper presents and analyzes the outcomes of research jointly supported by the MEHE and the Palestine Trade Center (PALTRADE) in order to assess whether the output of engineering education programs at the Palestinian universities meet the needs of the private sector, in particular. The private sector is the major employer of the engineers graduating from local universities.

The evaluation presented in the study comes 25 years after the establishment of engineering education systems in the Palestinian universities in order to arrive at recommendations to realize the systems' objectives. Recent trends, as identified by Accreditation Board for Engineering and Technology (ABET), consider such evaluation to be of great importance, as the academic society needs to listen to the customers to establish outcomes that engineers should achieve [1].

More specifically, the aim of the study is to come with concrete and practical recommendations to develop the educational engineering programs in the Palestinian universities in response to the current and future needs of the local private sector, and to provide high standards and sound engineering education programs. To this end, the study objectives are as follows:

1. To identify the role which engineering graduates of Palestinian universities have in the private sector.
2. To specify the strengths and weaknesses of engineering graduates of the Palestinian universities in various disciplines compared to their counterparts in other universities, according to the local private sector.
3. To identify important areas, subjects, and topics which the private sector believes should be included or added to the educational pro-

grams, in order to satisfy the needs of the private sector institutions and companies.

4. To identify the attitude of the engineering deans and department heads towards the quality of the education programs they offer, and their willingness to accommodate the opinions of the private sector on what engineering education outputs are needed.
5. To come up with recommendations to develop and upgrade the engineering educational programs, remedy the weaknesses, and promote the strong aspects of engineering education.

### DEVELOPMENT AND STATUS OF ENGINEERING EDUCATION

Engineering education programs were initiated in the Palestinian Territories in 1978, just after the establishment of the first two leading Palestinian universities: An-Najah National University in Nablus and Bir Zeit University near Ramallah, both in the West Bank. Later on, in 1992, the Islamic University in Gaza established the only Faculty of Engineering in the Gaza Strip. Another two engineering education programs were established at the Palestine Polytechnic University in Hebron and at Al-Quds University in Jerusalem, in 1995 and 1999 respectively. Table 1 summarises the development of engineering education programs in the Palestinian universities.

These universities award a B.Sc. degree in nine different disciplines. All follow the semester model, where the students in general are required to complete 165–182 credit hours for graduation, extending over a five-year period. The first three established universities started programs to grant M.Sc. degrees in a limited number of engineering disciplines in 1991. However, the focus of this study will be on the assessment of education programs at the B.Sc. level.

In 1985, the universities and other concerned entities established the Palestinian Higher Education Council to coordinate, direct, and support higher education programs. A number of economic, social, and political factors affected the development of the higher education programs. The economy of the Palestinian Territories was annexed to the Israeli economy, and it was difficult to link the engineering education disciplines to the technological needs of Palestinian society [2].

Table 1. The development of engineering education programs in Palestinian universities

University	Year of Establishment	Number of Departments	
		At Year of Establishment	At Start of 2002/2003
An-Najah National University	1978	2	8
Bir Zeit University	1978	3	4
The Islamic University in Gaza	1992	2	4
Palestine Polytechnic University, Hebron	1995	4	4
Al-Quds University	1999	1	2

During the early 1990s, when a Palestinian national authority was emerging, a number of studies were conducted by Palestinian academics and UNESCO experts on the anticipated role of higher education in development. A comprehensive development study, prepared in 1992, highlighted the necessity to locally educate and train the human resources needed as one of the prerequisites to developing an independent Palestinian economy [3]. It emphasized the role of higher education, especially in engineering and other technical disciplines, in the anticipated development of the industrial sector. Similarly, an official study was prepared by a group of Palestinian experts in 1994, which stressed the need to upgrade current technical education programs to meet the challenges of development and reconstruction [4]. A study presented how such objectives can be met, and considered a model to establish industry-related disciplines, while maintaining and upgrading the already operational construction-related disciplines [5].

Two other studies prepared by UNESCO identified the need to modify current technical education programs, through establishing and developing specific technical and engineering disciplines [6, 7]. One of these studies argued that higher education institutions should cooperate with the private and public sectors, the employers of the graduates of these universities, in order to consider developmental needs in the effort to upgrade engineering education programs [7].

As part of the PNA's bodies established in 1994, the Ministry of Higher Education (recently combined with the Ministry of Education) became the authority in charge of coordinating, directing, and supporting higher education. In 2001, the

Ministry prepared a ten-year national strategy for higher education, which included a section devoted to engineering education [8]. This section presented the general developmental framework aimed at upgrading engineering education programs, indicating the need to link these with the needs of the developing Palestinian economy, on one hand, and the need to concentrate on quality, skills, and capabilities that will better prepare the engineering graduates for professional practice, on the other.

Statistical information indicates that, since the academic year 2000/2001, there were 5,137 undergraduate students studying engineering out of 75,579 university students enrolled in all Palestinian universities, or 6.8% of the total. This figure presented an eightfold increase in the number of students enrolled in engineering education programs over ten years (i.e. during the academic year 1990/1991) [9, 10]. However, the increase in engineering enrollment was parallel to a similar increase in total enrollment in higher education during the same period, as the share of engineering enrollment increased only modestly: about 6.5% in 1990/1991. Figure 1 illustrates the trends in the enrollment of engineering students in universities during the period 1990/1991 to 2001/2001.

The number of engineering graduates from Palestinian universities increased considerably during the last decade. Figure 2 illustrates this trend during the period 1991 to 2001. Additional statistical data, gathered by the Engineers Associations in the West Bank and the Gaza Strip, which keep a record of all engineering graduates, who are required to register with them to be able to practice the engineering profession, show that the

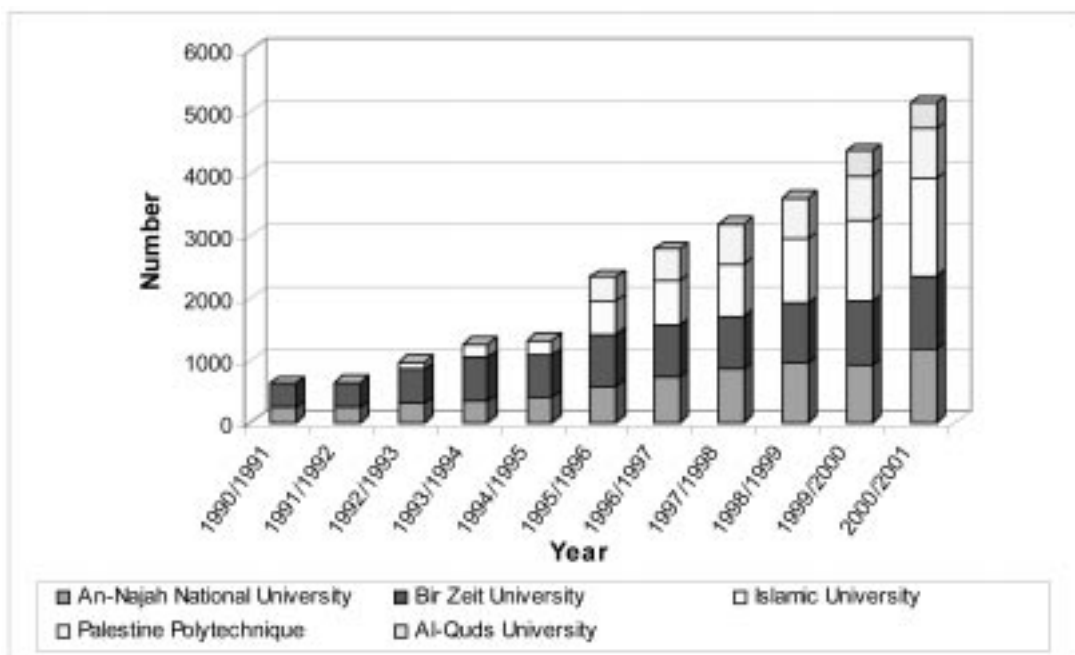


Fig. 1. Enrollment in engineering education programs in the Palestinian universities during the period 1990/1991 to 2001/2001.

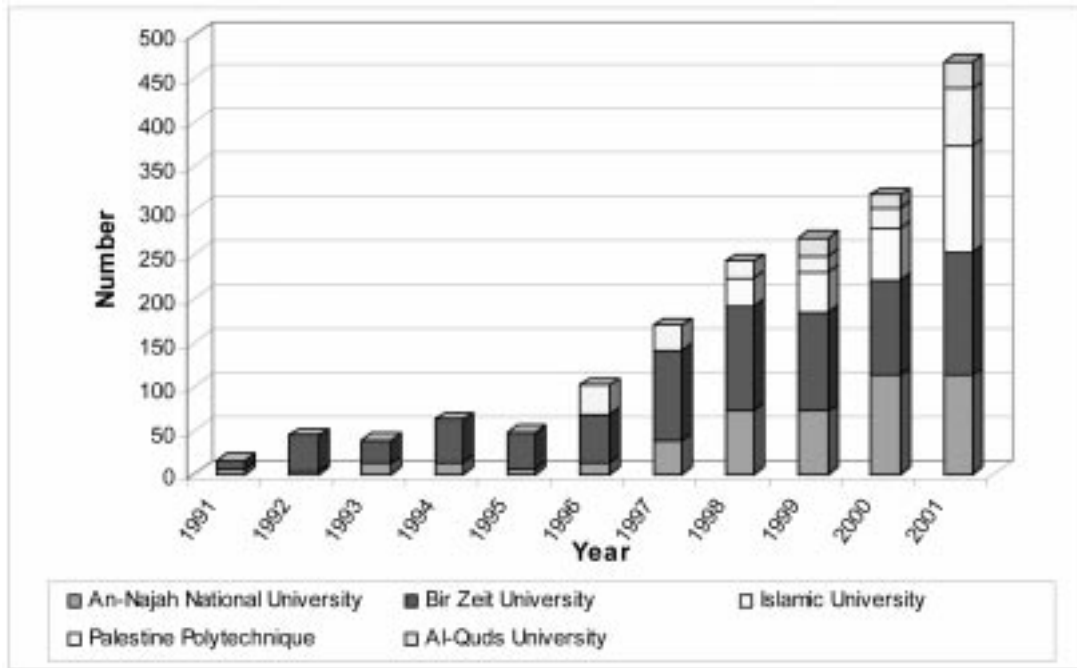


Fig. 2. Trends in the numbers of engineering graduates from Palestinian universities during the period 1991 to 2001.

percentage of local universities' engineering graduates in 2001 out of the total number of engineering graduates of all the universities during the same year was 67.0%, as opposed to 3.5% in 1991 [11]. This indicates that engineering graduates from local universities became the dominant population of new engineering graduates. This trend is expected to continue, with the increasing enrollment of engineering students in the Palestinian universities. Figure 3 shows the number of engineering graduates from Palestinian universities

compared to those who graduated from other universities during the period 1991 to 2001.

The distribution of registered engineers who graduated from abroad (i.e. from universities in other countries) was as follows: 45% from Arab countries, 23% from East European countries, 12% from Asian countries, 10% from West European countries, and 10% from the USA and Canada [11].

The majority of the teaching faculty in Palestinian universities is of Palestinian origin.

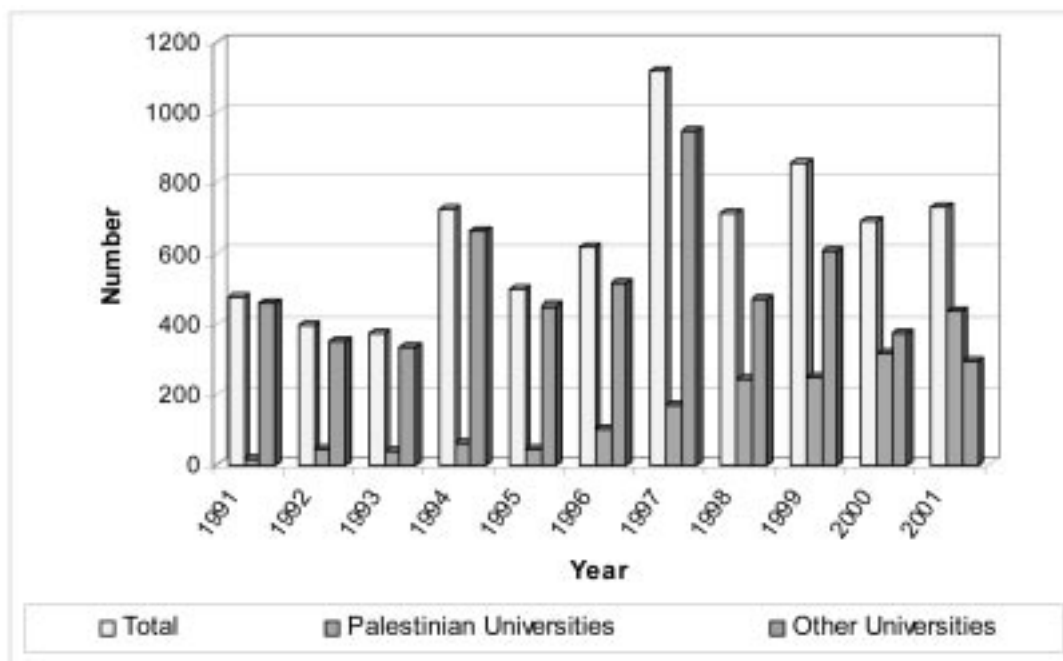


Fig. 3. The number of engineering graduates from Palestinian universities compared to those who graduated from other universities during the period 1991 to 2001.

Other nationalities cannot be easily attracted to work in the Palestinian universities, as the Israeli authorities have put severe restrictions on visas permitting foreigners to stay in the Palestinian Territories. Over the years, instructors with B.Sc. or M.Sc. degrees were granted scholarships to get Ph.D. degrees from European and American universities. The distribution of faculty, based on the highest degree attained, indicates that 66–77% of them had a Ph.D. degree, except in the Polytechnic University, where the corresponding percentage stood at 26% only [12]. The rest of the faculty had M.Sc. degrees.

Finally, the distribution of faculty, based on source of recruitment, indicates that 45% of them completed their highest degrees in the USA and Canada, 34% in Western Europe, 8% in Asia, 7% in the Arab countries, and 6% in Eastern Europe [12].

## RESEARCH METHODOLOGY

In order to realize the private sector's assessment of the outputs of the local universities' engineering education in fulfilling their needs, a special questionnaire was designed to explore the opinions of a sample of private sector company managers. In addition, a sample of academic faculty composed of deans and department heads who administer engineering educational programs were interviewed to examine their assessment of the current engineering education programs and their response to the concerns of the private sector. The surveys were conducted during the period December 2002 to January 2003.

Despite recent efforts to develop employer surveys for assessing a number of outcome indicators for various engineering programs, such as those required by ABET Engineering Criteria 2000, the need still exists to develop a methodology that is specifically oriented towards situations such as that in the Palestinian Territories. In these territories, the engineering educational system is still evolving and there are features of their status that are similar to those of other economies in transition. Such efforts include those of Evans *et al.* [13], Scales *et al.* [14], and Owen *et al.* [15]. It should also be mentioned that there have also been similar efforts in the region: either proposing approaches to assess program outcomes, such as in Naji *et al.* [16], or carrying out employer surveys to obtain feedback on some key issues of their programs, such as in Yigit *et al.* [17] and Christoforou *et al.* [18].

The private-sector questionnaire included a general information section, followed by a section to be filled in with details about each of the engineers employed by the company who had graduated from local universities. The third section of the questionnaire was designed to assess the extent to which the local universities' engineering graduates working in their firms differed from the

engineers who graduated from other universities. This was followed by a final section asking what topics or courses the respondent would like to see added to the current curricula or programs, in addition to any other recommendations the respondent may like to make.

Evaluation of the degree to which the local engineering graduates meet the needs of the private sector was performed by asking the private companies' representatives to assess 17 selected areas of strengths and weaknesses which may characterize the engineering graduates from local universities. A five-point scale was used in the assessment of each area of strengths or weaknesses, ranging from strongly agree to strongly disagree. In addition, cross-relations among these areas were established. The respondents were asked to rank these from the most distinct to the least.

A sample of 21 companies was selected to cover six fields, which covered the major fields of employment for engineering graduates in the private sector. The sample was selected from about 90 companies, which employed engineering graduates from local universities, and where the total number of employed engineers in any of these firms was at least five. Completed questionnaires were collected from 17 of these companies, showing a response rate of 81%. The sample was geographically distributed to cover various parts of the West Bank (71%) and the Gaza Strip (29%). The distribution of the employers in these fields is as follows: consultancy (30%), general contracting (18%), engineering materials (18%), industry (12%), telecommunications and computing (12%), and engineering management (12%).

The sample of academic sector representatives interviewed included 15 (67% from the West Bank and 33% from the Gaza Strip) out of a total of 26 deans and department heads who administer engineering educational programs in the Palestinian universities. The sample included academic faculty in charge of engineering programs in all the available nine disciplines of civil, architectural, building, mechanical, electrical, electronic, computer, industrial, and chemical engineering.

The interviews were conducted to gather information from the respondents on their assessment of the outputs and quality of engineering education which their programs offer. The interviews also ascertained the academic sector representatives' evaluation of the strengths and weaknesses of their graduates as identified by the representatives of the private sector. Finally, they were asked about their relationship with the private sector, and their willingness to consider the topics and issues raised by the private sector's representatives when developing their curricula.

The results of the questionnaires and interviews were analyzed by using the Statistical Package for Social Sciences (SPSS), version 8.0 for Windows. Based on the results of such analyses, conclusions were then drawn. The results of the study were presented in a special workshop, to which

representatives of the universities, the private sector, the MEHE, and the Engineers Associations were invited. Valuable feedback was obtained and relevant comments were noted, which enabled a number of conclusions and recommendations to be drawn up. These have been circulated to the parties concerned.

**THE PRIVATE SECTOR VIEWPOINT**

This section presents the results of the study based on the information gathered from the private companies' representatives through the questionnaires. The results of analysis of the overall status are presented first. This is followed by a presentation of analysis of the areas of strengths and weaknesses which are believed to characterize the engineering graduates from local universities. Finally, the private sector suggestions for meeting their needs are illustrated.

*Overall status*

The results indicate that the engineering graduates from the local universities were respected and had a considerable role in the private-sector establishments, despite the relatively late establishment of higher education in Palestinian universities compared to other universities in the region. Recently, about 11% of the engineers in the sample who graduated from local universities were promoted to managerial positions in their firms.

In the sample of the surveyed companies, 58

engineers had graduated from local universities out of 137 engineers working in the surveyed firms, making 42%. Female graduates formed a significant percentage: 29% of engineers who graduated from local universities and worked in these firms.

The results showed that, for each of the firms surveyed, the percentage of engineers who had graduated from local universities out of the total number of engineering staff working in these firms ranged from 10% to 100%. The field which offered the highest percentage of employment opportunities to local university engineering graduates out of the total number of engineering staff working in the surveyed firms in that field was found to be the growing telecommunications and computers field, where local graduates constitute 54% of the total. Conversely, the field of industry exhibited the lowest percentage across the indicated fields at 18%.

The results of the analysis also indicated that the majority of the graduates from local universities (68% of the total) were employed in private-sector firms based on competition with other graduates. About 11% of the employed graduates of local universities had been engaged in engineering training in the same companies in which they were later employed.

*Areas of strengths and weaknesses*

Seventeen areas of strengths or weaknesses were investigated. For each of these areas, the representatives of the private sector firms were asked to evaluate to what extent the engineers working in their firms who had graduated from local

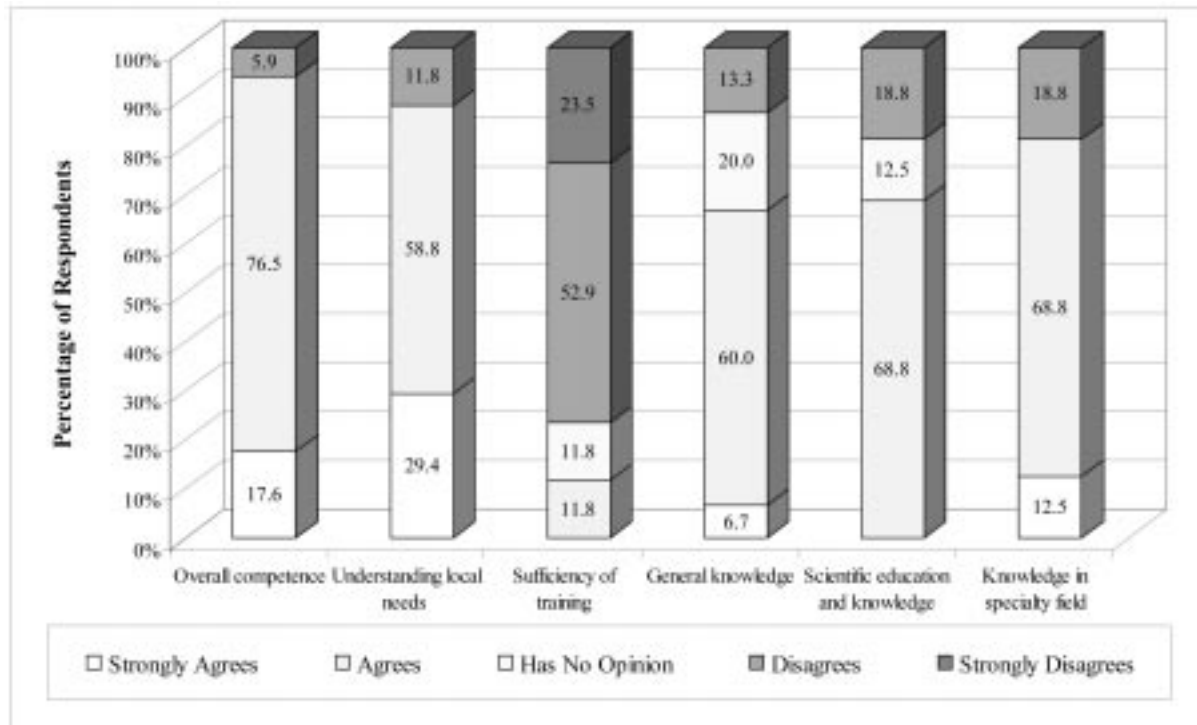


Fig. 4. Private sector representatives' opinions regarding the general indicators of local university engineering graduates.

universities were more or less distinct from the engineers who had graduated from other universities. The results of analysis for each of the areas investigated were illustrated first, then the cross-relations between these areas were presented.

For the purpose of analysis, the investigated areas were grouped into three groups: general indicators, capability indicators, and skills indicators. Highlights of these are presented below. The results were illustrated graphically as well.

**General indicators.** This group of indicators includes overall competence, understanding local needs and specifics, general cultural knowledge, scientific education and knowledge, education and knowledge in the field of specialty, and the adequacy of practical training. Figure 4 represents the results of analysis of the general indicators.

Regarding overall competence, 94% of the companies' representatives agreed or strongly agreed that the target group was more competent than those who graduated from other universities. This is attributed to the high level of competition for admission to local universities, and the quality of education, despite the difficult circumstances and the restrictions imposed by occupation during the early stages of development of the engineering education programs in the Palestinian Territories. More than 88% agreed or strongly agreed that the target group possessed more understanding of local needs and specifics. This may be attributed to the fact that most of the engineering faculty practice in the engineering profession, and their students benefit from this experience. In addition, local site visits and local training

opportunities, as well as dealing with local materials, contribute to such understanding.

General cultural knowledge, and scientific knowledge and education all have similar status. Around 68% of the respondents agreed or strongly agreed that the target group was better than their colleagues graduating from other universities in these areas. However, the majority of respondents (81%) indicated that the target group seemed to have better knowledge in specialized fields of engineering. This can be attributed to the effort invested in preparing students in the fields of specialty, as there were many specialized compulsory courses and a number of technical elective courses which the student had to take.

Finally, only 23.6% of the respondents agreed or strongly agreed that there was sufficient practical training for local university graduates. However, practical training seemed to have serious shortcomings and should be re-evaluated accordingly.

**Capability indicators.** The evaluated graduates' capabilities included those related to analysis, innovation and creativity, technical writing, scientific research, and leadership. Figure 5 illustrates the results of analysis related to these indicators.

Some 82% of the respondents agreed that engineering graduates from local universities had better analytical capabilities compared to those who graduated from other universities, while only 18% disagreed or strongly disagreed. This indicates that the Palestinian universities were successful in developing the students' analytical capabilities, which are the key to design and innovative thinking. Many analytical courses were offered in the third and fourth years.

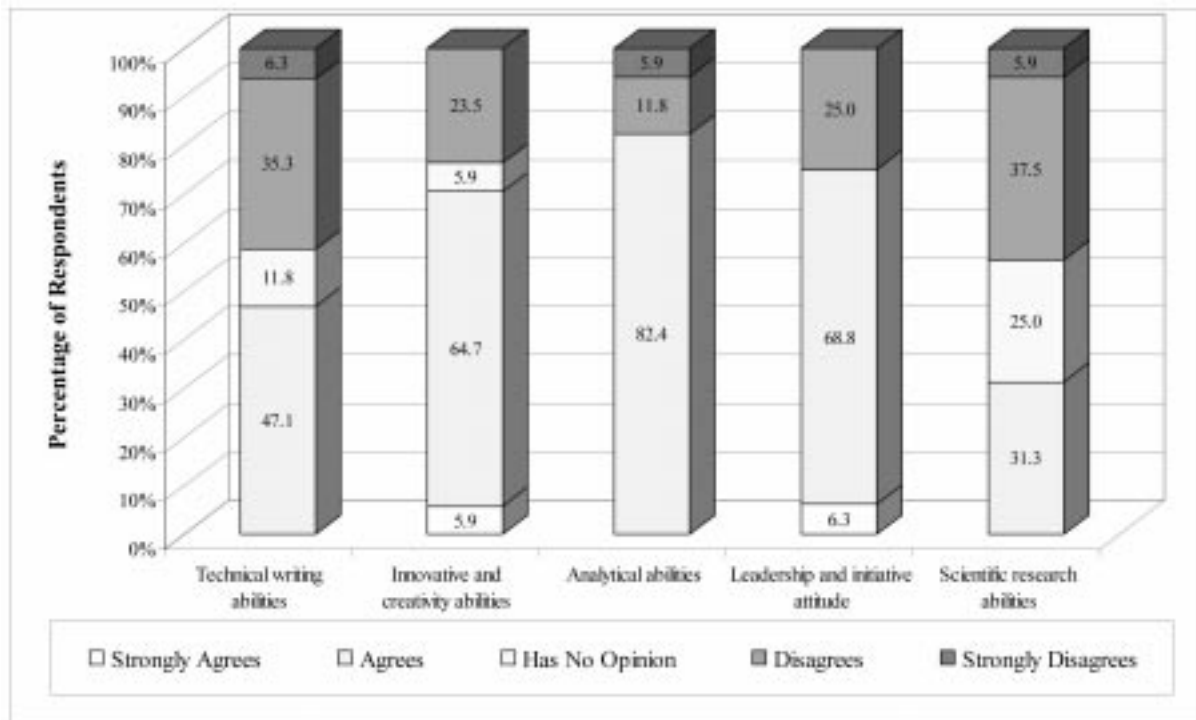


Fig. 5. The opinions of the private sector representatives regarding the capability indicators of local university engineering graduates.

The results showed that 71% of the respondents agreed or strongly agreed that graduates from local universities had good innovation and creativity abilities. Graduates from local universities gained and developed innovative and creative problem-solving skills during their last two years.

Only 47% of the respondents agreed with the assertion that graduates from local universities had better technical writing and report preparation abilities, while 41% did not agree. This indicated that technical writing was one of the fields where efforts should be made to develop curricula in order to satisfy the needs of the private sector in this regard, as, in general, no formal technical writing courses had been taught. In the same area, the results show that only 31% of the private sector representatives believed that the target group possessed better scientific research capabilities, while 44% did not believe so. This reflects the limited attention given to training the students in scientific research, as in most developing countries.

Finally, the majority of the respondents (75%) indicated that graduates from local universities had good leadership and initiative capabilities. This may not be attributed to the engineering curricula, but to the inherent abilities of the students, as well as to the fact that the faculty were able to enhance their students' capabilities.

**Skills indicators.** This group of indicators includes theoretical skills, practical and applied skills, general computing skills, applied technical computing skills, and linguistic skills. Figure 6 shows the results of analysis related to the skills indicators.

Regarding theoretical skills, 76% of the

respondents said that the graduates from local universities were more competent than the graduates from other universities. On the other hand, 53% of the subjects believed that the target group was more competent than the graduates from other universities in practical and applied skills. These results indicated that there was more concentration on theory in the engineering education programs offered, compared to the practical and applied aspects. In a number of programs, there are limited lab sessions and design projects, and even, in a few cases, especially in the newly established programs, a lack of lab facilities.

About 88% and 77% of the respondents expressed the belief that graduates from local universities had good general computing skills and applied computing skills in technical fields, respectively. Such results can be attributed to the presence of courses that have been developed, especially during the past decade, in computing and computer applications in the technical fields in all the Palestinian universities. In few cases, a high standard of special courseware has been developed using advanced computing and multimedia technologies, sponsored by the European Union and UNESCO. Moreover, computing labs and facilities have been significantly improved during the same period.

Finally, in the area of language skills, 69% of the respondents agreed or strongly agreed that the target group was more competent in mother language skills when compared to their respective graduates from other universities. On the other hand, only 41% of the respondents agreed that the target group was more competent in foreign

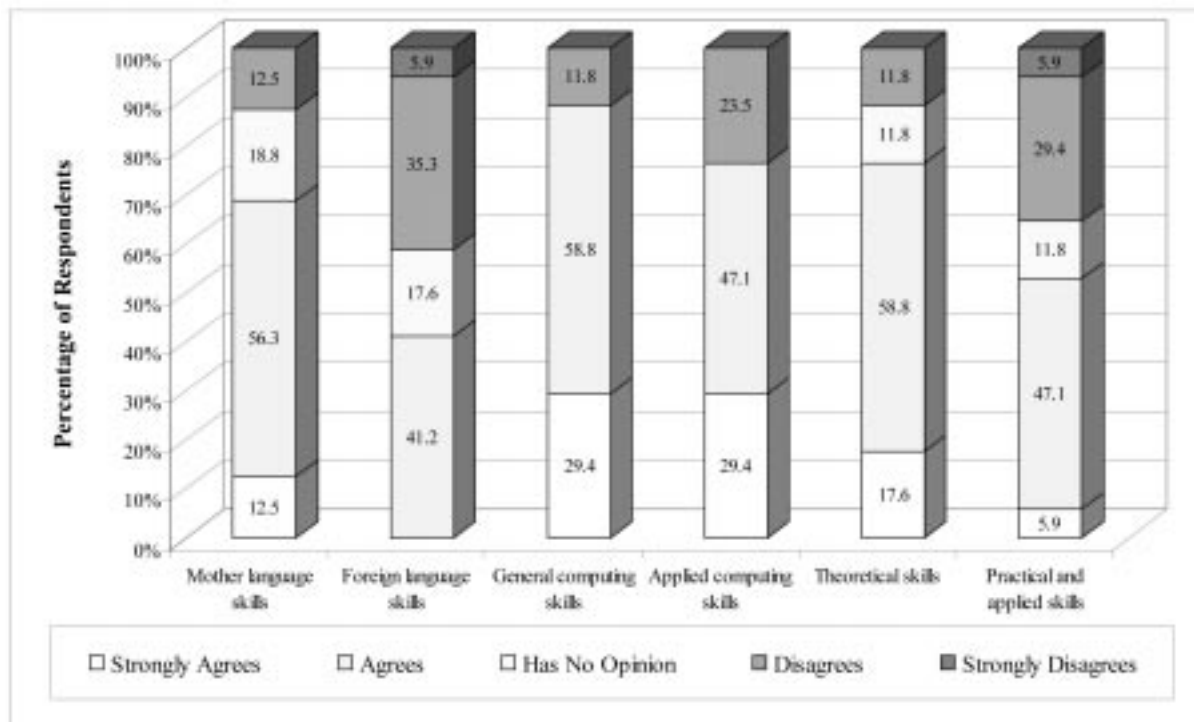


Fig. 6. The opinions of the private sector representatives regarding skills indicators of engineering graduates from local universities.



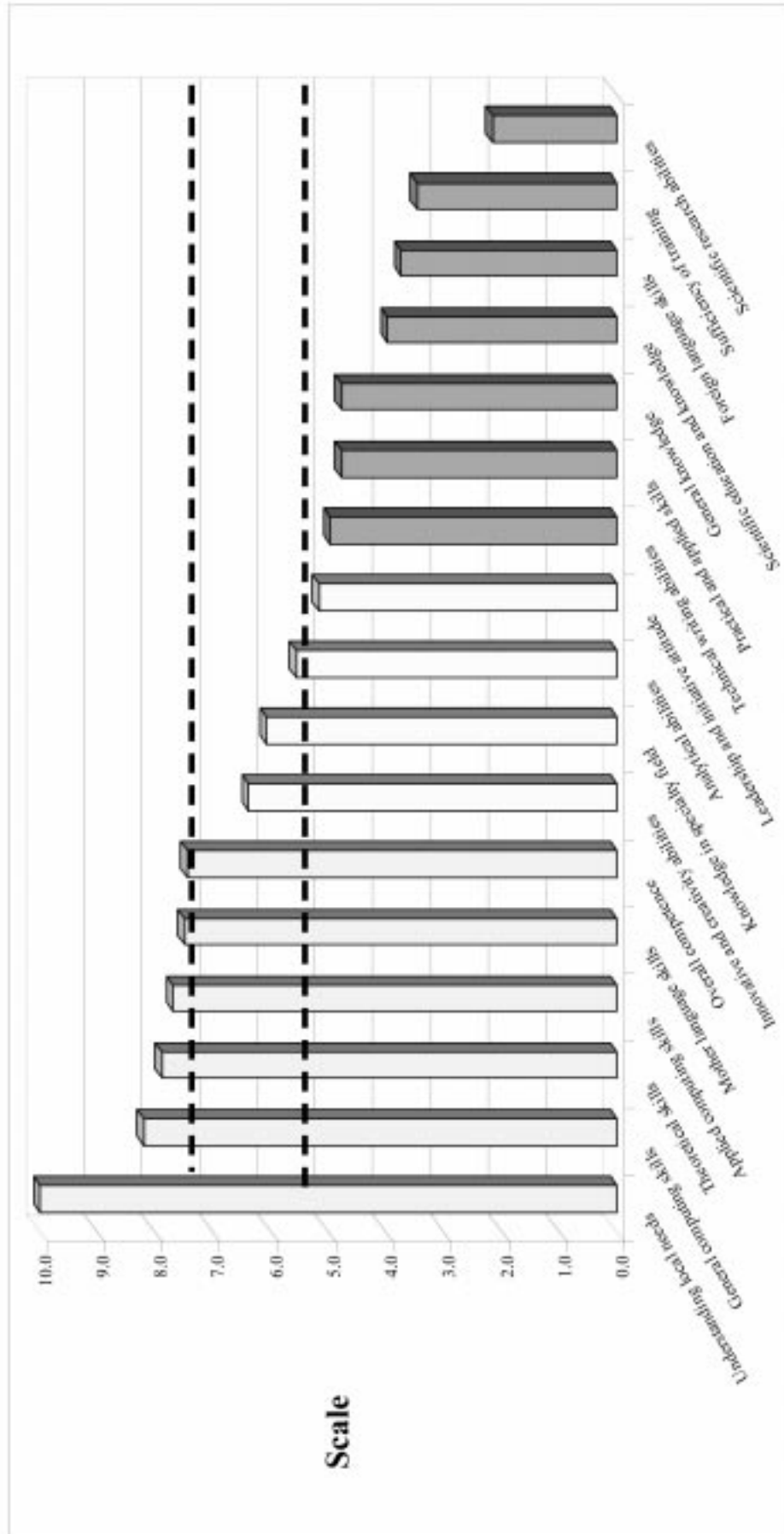


Fig. 7. Ranking of the strengths and weaknesses of engineering graduates from local universities by the private sector representatives.

languages, and the English language in particular. It should be noted that all the engineers working in the private sector are of Palestinian origin and nationality. These results reflect the fact that, although the official language for teaching is the English language, the language used to communicate in the technical field is usually a mixture of Arabic and English. Moreover, most of the graduates from other Arab and foreign universities were taught in other international languages, especially the English language.

**Relationship between the areas of strengths and weaknesses.** The private sector representatives were asked to rank the strengths and weaknesses of the graduates from Palestinian universities working in their firms from the most to the least distinguished. This measures the cross-relations between these areas. The results of analysis showed that the studied areas can be grouped into three categories: the most distinguished, where each attained a grade of 7 or more out of 10; the least distinguished, with a grade of less than 5 out of 10; and those in between, with a grade between 5 and 7. The results are presented in Fig. 7.

The results indicated that the areas of strength included (starting with the most favored) understanding the local conditions, needs and specifics, general competence in the use of computers, theoretical and scientific skills, applied computing skills in the technical fields, and mother language skills.

The areas of weakness included (starting with the least favored) competence in scientific research, adequate practical training, foreign (usually English) language skills, scientific knowledge, practical and applied skills, and technical writing.

**Private sector suggestions for meeting their needs.** The customers' views on curricula design and development are of great importance [13]. The results of the questionnaire regarding the suggestions of the private sector representatives for enhancing the local universities' programs in order to meet their needs were analyzed. The recommendations of the sampled customers can be summarised as follows:

1. A number of topics or courses should be added to the engineering curricula in the Palestinian universities to enhance the capabilities and skills of graduates, including linguistic skills (especially the English language), technical writing and report preparation, professional engineering practice, scientific research fundamentals, management, and economics.
2. More attention should be paid to specifications, contracts, engineering materials, and quality control right across all the engineering disciplines.
3. More attention should be paid to the practical and applied educational aspects of engineering education, by introducing more practical and design projects and more applied lab sessions into the curricula.
4. More attention should be paid to teaching the

students detailed design and enhancing their innovation and creativity-related capabilities.

5. The students' computer-related applied skills should be improved, especially in specialist fields.
6. There is a need to concentrate on developing the engineering students' managerial and administrative capabilities.
7. The practical training of students needs to be further developed, including increasing the training period, paying more attention to training contexts, and ensuring proper follow-up during training.
8. More specialties that concentrate on programs for graduate applied engineers and technologists should be available.
9. Sub-specialty engineering programs in fields that are in great demand—such as water and environmental engineering, construction management, automation, and industrial management—should be available to students.
10. Engineering educational policies should be defined within a national developmental framework, to orient engineering programs in terms of specialties, enrollment, and output quality.
11. Partnership programs should be established between the engineering faculties at the Palestinian universities and the private sector to continuously improve the quality of engineering education.
12. Engineering graduates should be offered short-term job opportunities through programs designed to smoothly bridge the gap between university and the real world.

## ACADEMIC OPINION

This section presents the attitudes of the Palestinian university engineering deans and department heads that were interviewed. They were asked about the appropriateness of the engineering education outputs to the private sector market needs, and about the extent to which the universities can accommodate the demands of the private sector within their educational programs. The main results are presented here in two sets, one on engineering education quality and the other on the relationship with the private sector.

### *Engineering education quality indicators*

The results showed that 60% of the respondents believed that their programs produced highly competent students, while 40% partly agreed with this. The majority of the respondents agreed that the universities provided sufficient facilities, labs, and educational resources to give quality education. Similarly, 60% indicated that they had enough specialty and computer labs, while 80% indicated that there was continuous modernization

of university libraries and other educational resources.

Only 33% of the respondents said that there was an appropriate ratio of faculty to students in their departments, while the rest partially agreed with this. This shows that these representatives of the academic sector have not, in general, seen an increase in faculty numbers to parallel the observed trend of increasing student enrollment and the establishment of new departments and programs. It should be noted that the overall ratio of faculty to students has decreased from about 1:10 to less than 1:25 over the past decade. This could have a negative impact on the quality of engineering education.

About 80% of the respondents indicated that they regularly updated their programs and curricula in the light of the recent developments and findings in their fields. For most of the departments, engineering education curricula have been updated during the past three years. New elective courses in the field of specialty have been added, as the students are required to complete 3–5 specialty elective courses.

As regards developing the students' theoretical and practical capabilities, 80% of the respondents believed that the students' theoretical capabilities have been developed to a large extent. This confirms the private sector representatives' viewpoint that local university graduates possess good theoretical capabilities. On the other hand, 67% of the respondents believed that their programs enhanced the abilities of the students in the analytical fields, while 27% indicated that this has only been achieved to a limited extent. Despite this, only 47% of the respondents believe that their programs enhance the innovation and creativity abilities of the students to a large extent, while the rest believed that this was only achieved to a limited extent. Again, these results reflect the opinions expressed by the private sector representatives.

The majority of the respondents (73%) believed that follow-up during practical training, whereby students are required to work in private or public sector institutions for a period of 6 to 12 weeks before graduation, occurs only to a limited extent. Finally, and with respect to students' skills, only 13% believed that students' technical writing skills were developed to a great extent and 67% to a limited extent, while 20% believed that English language skills were developed to a great extent and 53% to a limited extent. These results also corresponded with the viewpoints expressed by the private sector representatives.

#### *Relationship with private sector indicators*

The results of the interviews with the engineering education officials indicate that 33% consider, only to a limited extent, the opinions of the private sector representatives regarding the quality of their graduates. Only 7% of the respondents considered to a limited extent the opinions of the private

sector regarding the number of graduates needed by the private sector. In the same way, only 27% of the respondents considered to a limited extent the opinions of the private sector regarding the specialties and fields required by the private sector. These results show that there is very limited cooperation with the private sector on key qualitative and quantitative engineering education issues.

Regarding interaction with the private sector, about half the respondents (53%) considered the private sector viewpoint, but only to a limited extent, concerning the skills and capabilities that local university graduates should have. A similar share of the respondents stated that they followed up their graduates after graduation, only to a limited extent, in order to get the necessary feedback to modify and develop their programs and curricula. It is worth noting that almost all the engineering education officials stated that communication with the private sector is solely based on individual initiatives.

Despite the above, all the respondents expressed their willingness to learn of the concerns, opinions, and needs of the private sector and to incorporate their suggestions into their education programs as far as is possible.

## CONCLUSIONS AND RECOMMENDATIONS

One of the lessons learned is that it is necessary to seek the opinions of the customers. Their viewpoint is vital in order to ensure that the output of engineering education meets their satisfaction. This evaluation of the output of engineering education systems for an economy in transition illustrates how such systems can be modified in response to the needs of an evolving society.

The results indicate that the private sector representatives in the Palestinian Territories felt, in general, that the graduates from local universities were better qualified than the graduates of other universities. A considerable portion of engineers that have graduated from Palestinian universities work in the private sector establishments. The results also indicate that most of the local university graduates employed in private sector companies were appointed based on competition with graduates from other universities.

The most prominent area of strength is that which relates to the understanding of specific local needs and conditions. This is considered to be a significant prerequisite in arriving at solutions to the technical challenges and problems facing Palestinian society, especially during this transitional period leading up to the establishment of a Palestinian State, which is planned for 2005. Other strengths include general competence in computing, theoretical and analytical skills, and mother language skills.

Weaknesses that have been identified in the engineers who have graduated from Palestinian universities relate to lack of ability in scientific research and technical writing, lack of adequate training, insufficient practical- and application-related skills, and lack of appropriate English-language skills.

Based on the results of this study, the following recommendations have been identified, grouped as they relate to the universities, the private sector, and the MEHE.

#### *Recommendations for the universities*

- The engineering curricula should be modified by the addition or inclusion of relevant courses, subjects, topics, or activities in order to remedy the weaknesses of the engineers that have graduated from Palestinian universities.
- More attention should be paid to practical and applied considerations, including training, in order to promote a better balance between these and theoretical aspects.
- Additional qualified faculty should be appointed and the number of students in the sections and classrooms should be reduced in order to improve the quality of engineering education and reach acceptable ratios of students to faculty.
- Sufficient funding and research time should be allocated to faculty to perform applied research, as this is expected to be reflected in the students' research capabilities.
- Faculty should be encouraged to practice engineering, as this should then enhance the practical skills of their students.
- Communication with the private sector should be initiated in order to identify the sector needs, through needs assessment and market studies, with regard to the quality of engineering graduates and the number of graduates required by the industry.
- University–industry partnership programs should be established in order to facilitate feedback on output quality, applied research, training, and continuing education.

#### *Recommendations for the private sector*

- The private sector should provide engineering students with appropriate training opportunities to enhance their abilities and skills and motivate them to work in the private sector upon graduation.
- There should be cooperation between the private sector and the universities in establishing university–industry partnership programs. This could be achieved through initiating collaboration and supporting research at universities that would address problems experienced by the industry and assist in technology transfer and technical development.
- Absorption programs should be implemented providing short-term work opportunities to new engineering graduates to ensure smooth transition from the university into the real world.

#### *Recommendations for the MEHE*

- The quality of engineering education in the Palestinian universities should be regularly monitored by identifying and implementing accreditation measures, either in relation to existing or new engineering programs.
- The universities should be encouraged to establish disciplines that concentrate on the practical and applied aspects of engineering, including the establishment of new applied engineering programs aimed at graduating technologists and applied engineers.
- The universities should be provided with funds to support the establishment of modern laboratories and facilities, increase the number of qualified faculty, and encourage applied research, in order to improve the quality of engineering education.

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