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Are women engineers in Lebanon prepared for the challenges of an engineering profession?

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Are women engineers in Lebanon prepared for the challenges of an engineering profession?

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This study investigates the status of women engineers in the Middle East, considering women engineers in Lebanon as a case study. The author investigated the following questions: What are the influences behind females' decisions to choose engineering as their major course of study? What are the motives behind this decision? What are the perceptions of females regarding the essential skills for a successful engineering career? An online survey consisting of Likert-scale items was completed by 327 female engineers who graduated from universities in Lebanon and now work in various locations around the world. A genuine interest in the field appeared to be the main influence in the participants' decisions to choose engineering profession. The potential for professional growth was the leading motivator for choosing engineering. Although participants reported that they possessed adequate theoretical knowledge and technical skills before graduation, in the actual practice of engineering, they noted weaknesses in creativity and innovation.

Keywords: women in engineering; Middle East; engineering education

Introduction

Engineering is commonly assumed to be a male-dominated profession. Despite this, the number of women enrolling as engineering majors and practicing in the engineering profession has been rising. Although the involvement of women in engineering is increasing, they are still viewed as a minority in the field. In general, the proportion of women employed in technology-related fields is much lower than the proportion participating in the general workforce (2007). In the UK, for example, the 2006 Skills Survey examined the skills of 4800 working individuals aged 20–65 and compared them with those from similar surveys undertaken over the last two decades. The report provided an analysis of gender differences in relation to skills, including skills trends, qualification requirements, the value of skills, task discretion, and attitudes towards work and skill development. This survey showed that, compared to women, men are more likely to be employed in positions that involve complex and advanced equipment (Felstead et al. 2007).

In the USA, the attrition of women in undergraduate engineering programmes is significantly higher than that of males as revealed by the National Science Foundation (NSF 2008), with men earning the majority of bachelor's degrees in engineering (80%). Ongoing studies focus on the importance of increasing diversity in engineering and technology-related disciplines to attract more women to these fields (Zimmerman and Vanegas 2007). According to the National Center

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Table 1. Percentage of female enrolled in engineering in 2008 obtained from UNESCO Institute of Statistics 2010.

Country	Engineering (%)	Social studies, business and law (%)	Humanities and arts (%)
% Female			
Algeria	33	62	75
Bahrain	26	71	85
Jordan	25	42	67
Morocco	15	36	49
Oman	25	59	88
Palestine	31	46	70
Qatar	37	69	90
UAE	19	61	85
Australia	24	54	64
Denmark	36	52	65
France	23	63	71
Germany	19	53	74
Greece	39	65	69
Italy	31	57	74
Spain	27	63	61
Sweden	30	63	61
Switzerland	13	47	61
UK	21	56	62
USA	19	56	59

of Education Statistics (NCES 2009), 57% of all bachelor's degrees conferred in 2008–2009 were awarded to females. However, relative to males in engineering and engineering technologies, females earned the smallest percentage (16%) of bachelor's degrees.

In Canada, female enrolment reached a peak of 20.6% of total undergraduate engineering enrolment in 2001 and has fluctuated between 17% and 18% over most of the decade. In 2010, 17.7% of students enrolled in Canadian undergraduate engineering programmes were women, a slight increase from the percentage in 2009 (Engineers Canada 2010).

In Australia, female enrolment in engineering reached 24% in 2008 compared with 54% female enrolment in social sciences, business and law, and 64% females enrolment in humanities and arts. Also in 2008, in France, the proportion of women enrolled in engineering reached 23% compared with 63% female enrolment in social sciences, business and law and 71% female enrolment in humanities and arts as shown in Table 1.

Through an investigation of the factors for persistence of women engineering students in Europe, mainly in Germany, France, Austria, Great Britain, Finland, Slovakia and Greece, it was shown that the climate in the schools of engineering and the absence of faculty support play a major role in female attrition (Wächter 2005).

On the other side of the globe, in the Middle Eastern Arab Region, little information exists regarding women engineers. This lack of information about the integration of women into the engineering workforce suggests the need for an investigation of female engineers' status in Arab societies.

The lowest percentage of women (1%) enrolled in engineering programmes is in Saudi Arabia (ESCWA 2003). In fact, only last year, in the end of 2011, was it announced that King Abdul Aziz University in Jeddah would host the first government engineering programme for female high-school graduates. Private institutions have offered opportunities for Saudi Arabian women to study engineering since 1999, but this was the first public university to allow women to enrol in engineering fields (Al-Arabiya 2011). The decision was approved after 92% of female high-school students responded that they would like to enrol in engineering programmes and 80% of the parents responded that they would not mind if their daughters attended engineering colleges.

In the United Arab Emirates (UAE), where females comprise the majority of high-school graduates entering the tertiary level (UNESCO 2009), there is a preference for enrolling in majors other than Science, Technology, Engineering, and Math (STEM) fields such as social sciences, arts and business. Only a few years ago, in 2009, the Society of Women in Engineering (SOWIE) was established in the UAE as an initiative during the UAEs' First Annual Women in Engineering Event. The objective of the SOWIE is to provide a forum for women engineers in UAE and across the region to collaborate and to share expertise (Alhosn-University 2010).

The fact that Kuwait exhibits the highest percentage (49%) of enrolment of women in engineering is not surprising (ESCWA 2003). Since the early 1970s, the State of Kuwait has witnessed an enormous growth in female participation in higher education as well as in employment. It has been observed that females obtain higher scores compared to males not only in high schools but also even at the university level. This achievement generates a 'feeling of equality' with their male colleagues, as reported by a sample of Kuwaiti women engineers (Koushki, Al-Sanad, and Larkin 1999).

In a recent study conducted in Palestine, 10 contracting companies and 28 women civil and architectural engineers were interviewed to increase our understanding of the involvement of women in construction work (Enshassi, Ihsen, and Hallaq 2008). Although engineering firms expressed their willingness to hire women engineers, the majority stated their preference for men. It is important to mention that women engineers may not always have the freedom to travel or work on sites as the society is bound by specific cultural values and religious beliefs (Enshassi and Liska 2000). In fact, the Arabic culture is guided by the Islamic religion, where women are restricted from travelling on their own and are intimidated from working freely in a male-dominated environment.

When comparing the Middle East to Western countries, we notice that women strive on both sides of the globe not only to enter the world of engineering but also to succeed in the field. Nonetheless, the Middle Eastern culture encompasses a myriad of obstacles that women must overcome before they step into such a domain. Social norms may be a major obstacle that hinders women in pursuing a degree in engineering and consequently destroys the dream of some female high-school graduates.

Although engineering enrolment statistics for women in some Arab countries are impressive (Table 1), as revealed by the United Nations Educational, Scientific and Cultural Organization (UNESCO 2010), the path that women follow from engineering enrolment to career practice is not well understood.

For the purpose of this research, Lebanon was considered for a case study. As one of the best educational systems in the Middle East (Chehade 2001), Lebanon's higher education institutions are a productive source of new engineers for the Gulf Region. In fact, in the Middle East, Lebanon is regarded as a centre for engineering education (Baytiyeh and Naja 2011). Although Lebanon is an Arabic state, it is unique in the region for its diversity of religious and cultural backgrounds. The existing culture in Lebanon has emerged from the interaction of Western and Arabic cultures, providing unique and rich social values that are reflected in the educational system and in the life styles of the people.

Between 2005 and 2010, the enrolment of females in Lebanese engineering programmes fluctuated between 15.2% and 18.2% with a mean of 16.5%, according to the Centre for Educational Research and Development (CRDP 2011; Table 2). It is important to mention that the Lebanese University is the only public university in the country and offers a tuition-free education. All other universities in Lebanon are private and charge tuition. Moreover, the average ratio of male to female students at the Lebanese University is 3:1, whereas the average ratio at private universities is 5:1.

This study aims to explore Lebanese women's perceptions about their career path from enrolment in an engineering programme to their actual practice of engineering. This study investigates

Table 2. Enrolment of Female/male in the engineering programme in Lebanon from the CRDP.

	The Lebanese University		Private universities					
	Female	Male	Female	Male	Total F	Total M	Total	F (%)
2009–2010	837	2766	1250	6590	2087	9356	11,443	18.2
2008–2009	665	2203	1088	6020	1753	8223	9976	17.5
2007–2008	572	2170	854	5581	1426	7751	9177	15.5
2006–2007	509	1983	721	4890	1230	6873	8103	15.2
2005–2006	549	1724	710	4888	1259	6612	7871	16.0
2004–2005	653	1900	1368	7412	2021	9312	11,333	17.8

the following questions:

- What are the influences behind females' decisions to choose engineering as their major course of study?
- What are the motives behind this decision?
- What are the perceptions of females regarding the essential skills for a successful engineering career?

Factors that may influence students' decisions to enrol in engineering colleges include aptitude for the subject matter and advice from parents or peers. Several research studies have examined the influences and motives of women in their enrolment in engineering programmes. After surveying students in Lebanon, with no specific emphasis on female students, Baytiyeh and Naja (2010b) showed that a personal interest in the subject matter appeared to be the leading influence in students' decision to enrol in engineering. Ghazal-Aswad,Vidican, and Samulewicz (2011) investigated the factors that influence women in their decisions to enter STEM disciplines in the UAE and showed that educational choices are often made after consultation with the family and community members. In Palestine, Enshassi, Ihsen, and Hallaq (2008) showed that women are mainly motivated by their family to enrol in civil engineering and architecture. In Turkey, it was shown that women choose engineering mainly because they enjoy mathematics and science (Smith and Dengiz 2009). By investigating the motives behind enrolling in engineering programmes in Lebanon, Baytiyeh and Naja (2010) showed that job satisfaction is the main motivator for students.

However, when graduates start their profession, they are confronted with the realities of sustaining full-time work as they address environmental constraints, job insecurity and administrative tasks (Hettich 2000). Graduates face challenges associated with learning the norms and skills important to the organisation's productivity and performance, and they must deal with the potential disappointment resulting from unmet expectations. So, what are the essential skills for a successful engineering career?

The majority of available studies have focused on dissatisfaction in the engineering field, showing a gap between education and professional practice while stressing the importance of non-technical skills in the engineering profession such as communication, team coordination and planning (Domal and Trevelyan 2008; Domal, Stappenbelt, and Trevelyan 2008;; Trevelyan and Tilli 2007). Trevelyan (2007) called for a general classification for engineering practice, while other researchers believe that engineering is mainly the 'design process' (Eckert et al. 2004) or technical problem solving (Jonassen, Strobel, and Lee 2006). Sageev and Romanowski (2001) showed that recent graduates spend approximately 64% of their time on written or oral communication which reflects the need for developing adequate communication skills at college. Shappard et al. (2006) interviewed engineering faculty and students and concluded that engineering work becomes recognised as a social process. Focusing on the Arab Gulf States in an investigation of the gap between engineering education and practice, Akili (2005) examined vital issues that have been neglected and called for collaboration between colleges of engineering and industry.

Method and data collection

Available e-mail addresses of practicing women engineers were collected from professional engineering organisations. An online Likert-scale survey was sent to 1246 women engineers who had been practicing for no more than 10 years. Of the 1246 e-mails sent, 67 were returned with delivery errors. Of the remaining 1179 engineers, 327 completed the survey, representing a 28% response rate.

The survey included the following four sections:

1. The first section gathered general information and demographics from participants related to their major, years of work, work location and position title.
2. The second section measured different types of influences for enrolling in an engineering programme (Baytiyeh and Naja 2010). In this study, the first source of influence includes individuals, such as parents or relatives, friends or peers and school teachers, who may try to persuade students to choose a certain major (Chung, Loeb, and Gonzo 1996). Another source of influence includes interest in the subject, for instance, aptitude and interest in the field (Kelman 1961).
3. The third section investigated the motives for enrolling in the engineering major based on the following four motivational theories (Baytiyeh and Naja 2010). In the flow theory, some students might see the engineering profession as fitting their abilities and as inherently satisfying. This motivation is characterised by an intense focus and concentration, an integration of action and awareness, self-confidence in one's abilities and satisfaction in the activity itself (Nakamura and Csikszentmihalyi 2003). In the creation theory, students might view engineering as the path to specific opportunities that enable them to show creativity in a challenging environment. In this case, learning is particularly effective when students are constructing something for others to experience (Amabile 1996). In the social theory, the opportunities for travelling, working overseas and meeting new people may provide certain students a much-needed feeling of connectedness (Maslow 1987). Some students may hope to become a partner or a director of a company, searching for the social status and recognition that individuals need to feel important through self-respect and achievement. Finally, in the financial theory, students might expect certain outcomes and benefits, e.g. earning potential, availability of employment or employment security (Kristof 1996). These extrinsic rewards may drive a desire for not only high performance but also increasing social stature through the possibility of promotion and a consequent increase in prestige.
4. The last section identified the learning deficiencies that hinder the effectiveness of practicing women engineers by assessing their proficiencies before graduation and after beginning their profession in terms of technical, interpersonal and personal skills. Drawing from previous studies related to engineering practice using quantitative and/or qualitative approaches (Baytiyeh 2012; Baytiyeh and Naja 2010; Deans 1999; Domal, Stappenbelt, and Trevelyan 2008; Lang et al. 1999), this section of the survey investigated the three categories: technical, interpersonal and personal skills, using tables with nine indicators for each category, as defined in Table 3. Technical indicators are the hard skills and knowledge attained for both professional development and career advancement, including all types of learning opportunities, from theoretical knowledge to creativity and innovation (Speck and Knipe 2005). In the soft skills, interpersonal indicators are related to interaction, such as the ability to work as part of a group or team, openness to new ideas and verbal/nonverbal communication skills (Pearce 2008), and personal indicators refer to management, negotiation and conflict-resolution skills, including business policies, time management and planning (Flannes and Levin 2005). Participants were asked to rate the 27 indicators (on a scale of 5) in terms of how well they were trained in these skills before graduation (1= poor,

Table 3. Participants' demographics.

	Frequency	Percent
Major		
Civil	121	37
Mechanical	36	11
Electrical	108	33
Computer	62	19
Years work		
Less than two years	98	30
Two to five years	88	27
Over five years	141	43
Location		
Lebanon	203	62
Gulf region	46	14
Europe and North America	78	24
Position title		
Sales and production	46	14
Planning	39	12
Consulting	36	11
Design	95	29
Site	26	8
Management	69	21
Other	16	5
Study engineering again		
Yes	262	80
No	65	20

5 = excellent) and how important those skills are for their professional success (1 = not needed, 5 = extremely needed).

Results

Descriptive statistics were calculated to obtain the measures of central tendency and the measures of variability for each of the items. The participants were distributed among the following engineering specialisations: civil (37%), mechanical (11%), electrical (33%) and computer science (19%). The participants were primarily young women engineers who had been practicing for less than five years (57%), as shown in Table 3. The majority of the participants (62%) were working in Lebanon; the remaining 38% worked abroad: 14% worked in the Gulf Region, and 24% worked in Europe and North America. The participants were mainly working in design (29%), management (21%) and sales and production (14%). When asked whether they would choose an engineering major if they had the chance again, 80% of the participants affirmed their selection of this major.

What are the influences behind females' decisions to choose engineering as their major course of study?

Women engineers were asked to rate the importance of different sources of influence on their decision to choose an engineering major (Table 4). The results showed that the highest ranked item is the students' own decision ($\mu = 4.6$), followed by their interest in the subject matter ($\mu = 4.1$) and aptitude for the subject matter ($\mu = 4.1$). Additionally, the influence of parents/relatives appears as one of the important factors ($\mu = 3.1$). On the other hand, the ranking of the school's influence is very low ($\mu = 2.4$), followed by the influence of friends or peers ($\mu = 2.2$).

Table 4. Influences to enrol in an engineering programme. The items with the highest average are in bold.

	Mean	SD
Advice from parents or relatives	3.1	1.4
Friends' or peers' influence	2.2	1.3
Family member is an engineer	2.6	1.4
My own decision	**4.6**	0.7
Aptitude for subject matter	3.7	0.9
Personal interest in the subject matter	**4.1**	0.9
High school Guidance	2.4	1.3

What are the motives behind females' decisions to choose engineering?

Women engineers were asked to rate 16 items related to the motivational theories explained above. An exploratory factor analysis (EFA) was employed to determine which of the 16 items formed related subsets. EFA combines factor variables that are correlated with one another but largely independent of other subsets of items (Rummel 1970; Tabachnick and Fidell 2007). This method was used as an expedient way to identify a smaller number of constructs (subsets) that represent the Likert-scale items. To form the potential factors, EFA was applied with principal components extraction, eigenvalues greater than 1.00 and absolute values of more than .40 (Field 2005; Ho 2006). A Kaiser–Meyer–Olkin measure of sampling equal to .728 and a Bartlett's test result of $p < .0001$ showed that the use of EFA is appropriate for this study (Kaiser 1970). The EFA with the principal components extraction yielded four factors accounting for 61.9% of the total variance. Table 5 shows the rotated factor loadings, which are the correlations between the variable and the factor. For items that were loaded under two factors, only the higher loading was retained. Through evaluation of the items loaded under each factor as listed in Table 5, descriptive names were generated. Factor 1 (with variance $\sigma^2 = 29.8\%$) was labelled *Financial Growth*, factor 2 ($\sigma^2 = 13.0\%$) as *Social Growth*, factor 3 ($\sigma^2 = 10.8\%$) as *Personal Growth* and factor 4 ($\sigma^2 = 8.1\%$) as *Professional Growth*.

Four new variables were computed on the basis of the mean of the items falling under each factor. A one-way repeated measures ANOVA was conducted to detect the main effects between

Table 5. Motivation factors, Rotated factor matrix with extraction method: principal component. Rotation method: Varimax with Kaiser Normalisation.

	Component			
Items	Financial growth	Social growth	Personal growth	Professional growth
Availability of employment	.844			
Promotion prospects/opportunities	.679			
Earnings potential	.667			
Prestige of the Profession	.642			
Employment security	.331			
Potential to travel		.825		
Opportunity to work for a large corporation		.689		
Opportunity to work overseas		.524		
Possibility to be director of a company			.682	
Self-employment opportunity			.653	
Becoming a partner in a partnership			.612	
Potential for professional growth				.466
Challenging and exciting profession				.846
Career flexibility and options				.845
Opportunity to be creative				.692
Job satisfaction				.628

the located variables. The results revealed significant differences among the four factor scores ($F(3, 978) = 62.59$, $p < .0001$). *Professional Growth* appeared as the most powerful motivator for enrolling in the engineering major ($\mu = 4.1$ on a 5-point scale), followed by *Financial Growth* ($\mu = 3.8$), *Social Growth* ($\mu = 3.6$) and *Personal Growth* ($\mu = 3.3$).

Bonferroni's method was applied to detect any significant differences between the factors, and *Professional Growth* and *Financial Growth* were found to be statistically significant ($p < .05$).

What are the perceptions of females regarding the essential skills for a successful engineering career?

In the last section of the survey, participants were asked to rate 27 indicators, reflecting *Technical*, *Interpersonal*, and *Personal Skills* (Table 6), in terms of how well they were trained in these skills before graduation (1 = poor, 5 = excellent) and how important those skills are for their professional success (1 = not needed, 5 = extremely needed). The three sets of skills, before and after graduation, were compared as a whole-group entity. Three variables were computed on the basis of the before-graduation mean of the items falling under each set of skills. Cronbach's alpha was calculated for each of the sets, with a value of .881 for *Technical Skills*, .910 for *Interpersonal Skills* and .808 for *Personal Skills*. A one-way repeated measures ANOVA indicated significant differences among the three set scores for college: ($F(2, 652) = 9.85$, $p < .001$). The *post hoc* tests using Bonferroni's method indicated that all differences are significant ($p < .05$) except those for before-graduation *Technical* and *Personal Skills*, whose scores are almost equal.

Table 6. The 27 indicators reflecting technical, interpersonal and personal skills. The items below the average are in bold.

	Before starting career		After practicing engineering	
	Mb	SD	Ma	SD
Technical skill indicators				
Theoretical knowledge	3.71	.85	3.39	1.0
Transforming knowledge to product	**2.65**	.96	4.08	.98
Learn a new subject on your own	3.80	.96	4.31	.73
Conduct experiment on your own	**2.72**	.94	3.36	1.1
Using technological tools	3.07	1.0	3.77	1.0
Model and formulate problems	3.39	.89	4.15	.90
Possessing computational skills	3.66	.89	4.03	.98
Solving engineering problems	3.39	.92	4.27	.90
Creativity and innovation skills	**2.63**	1.1	3.76	.92
Interpersonal skill indicators				
Presentation skills in foreign language	3.09	1.0	4.11	.76
Written communication in foreign language	3.27	1.0	4.40	.74
Oral communication in foreign language	3.15	1.1	4.28	.77
Make decision and accept responsibility	3.16	1.0	4.42	.59
Confidence in dealing with others	3.02	1.0	4.42	.66
Ability to effectively work in a team	3.10	.97	4.47	.68
Openness to new ideas	3.48	.97	4.06	.79
Motivate others for a given task	**2.50**	1.1	3.73	.83
Be willing to take risk	**2.73**	1.1	3.23	1.1
Personal skill indicators				
Leadership and managerial skills	**2.35**	1.0	4.65	.86
Knowledge of business and public policies	**2.05**	.97	3.50	.99
Ability to work under pressure	4.29	.85	4.14	.67
Preparedness for continued learning	3.96	.89	3.82	.85
Ability to manage your time	3.46	1.0	4.53	.65
Planning skills	2.95	1.1	4.29	.77
Flexibility in dealing with others	3.37	.96	3.61	.81
Ability to be goal oriented	3.25	1.0	4.09	.80
Possessing professional ethics	3.72	1.0	4.13	.97

For the sets of skills examined after beginning a career, three variables were also computed on the basis of the mean of the items falling under each set of skills. Cronbach's alpha was calculated for each group, with a value of .763 for *Technical Skills*, .815 for *Interpersonal Skills* and .772 for *Personal Skills*. A one-way repeated measures ANOVA indicated significant differences among the three set scores after starting the engineering career ($F(2, 652) = 39.74$, $p < .001$). The *post hoc* tests using Bonferroni's method indicated that all differences are significant ($p < .05$) except for those of after-graduation *Interpersonal* and *Personal Skills*, whose scores are almost equal. Moreover, a paired samples t-test was applied, and the three sets of skills as rated by women engineers before graduation and after starting their career were compared. The results showed significant differences ($p < .05$) for the three sets, mainly with regard to *Interpersonal Skills*, with a mean of $\mu = 3.05$ before graduation compared to $\mu = 4.12$ after starting a career, and *Personal Skills*, with a mean of $\mu = 3.26$ before graduation compared to $\mu = 4.08$ after starting a career.

Overall, in this section, three tests were performed: the first was conducted to compare the before-graduation skills and revealed that all differences are significant ($p < .05$) except that between *Technical* and *Personal Skills*. The second test was employed to compare the after-graduation skills and revealed that all differences are significant ($p < .05$) except that between *Interpersonal* and *Personal Skills*. The last test was conducted to compare the before-graduation with the after-graduation skills and revealed a significant difference ($p < .05$) between all the before and after skills but particularly between the before and after *Interpersonal Skills* and between the before and after *Personal Skills*.

Discussion

The majority of participants belong to the civil and electrical engineering fields. An interesting finding was that 20% of the participants reported that they would not choose engineering as a profession again. Previous research has highlighted the apparent contradiction that women have high grades but a low value for engineering (Matusovich, Strveler, and Miller 2010). Although women doubt their choice, they persist in pursuing their degree. Wächter (2005) showed that the drop-out rate of female engineering students in Europe is mainly influenced by a discouraging atmosphere in the departments and the non-support of faculty members. Therefore, it is essential for women to feel that they belong to the engineering community.

When women engineers rated the importance of different sources of influence on their decision to enrol in engineering, the highest ranked item was the students' own decision, followed by their interest in the subject matter. The students' own decision derives from their willingness to become an engineer for social status or financial opportunities, whereas students who have interest in the subject matter possess prior knowledge about engineering programmes, which encourages them to enrol in the field (Baytiyeh and Naja 2010). The influence of genuine interest in the subject matter corresponds to previous research reporting that a student's interest in the subject matter ranks highly in determining the student's selection of a major (Walstrom et al. 2008; Zhang and Fan 2007). As such, Smith and Dengiz (2009) showed that women in Turkey choose engineering mainly because they enjoy the underlying mathematics and science. Similar results were found in several countries in Europe: Austria, Finland, France, Greece, Germany, Slovakia and UK, where students who were pursuing engineering declared a high interest in sciences and technology (Béraud and Cooper 2005).

The influence of parents/relatives on Lebanese women also appeared as one of the important factors for choosing an engineering major. In the UAE, women revealed that consultation with parents is the primary influence on their decision (Ghazal-Aswad, Vidican, and Samulewicz 2011). In Palestine, women are also mainly motivated by their family to study civil and architectural engineering (Enshassi, Ihsen, and Hallaq 2008). This finding may reflect some patterns in Middle

Eastern culture regarding education, beliefs and values, particularly the tendency of parents to be overprotective of their daughters. Beraud and Cooper (2005) investigated the role of the family in one's decision to choose engineering and found that in most European countries engineers receive an enormous amount of support from their families with the exception of Slovakian engineers. This factor has also been recognised in previous research studies as a primary determinant in children's career development (Otto and Call 1985). For example, Blustein (1994) synthesised relevant literature in this field and suggested that the family's role is an important factor in children's career development.

Surprisingly, the rate of a school's influence is very small; this suggests that the influence of high school on the students' decisions is almost nonexistent. Obviously, the school plays a major role in providing students with the knowledge they need for the best, most challenging jobs. However, one of the main roles of schools is to provide students with adequate guidance and orientation for their major and career choices. It is not clear whether such a low rate of influence reveals failure and negligence in the school guidance process or reflects some disregard by students for such guidance.

With the objective of investigating the motives behind choosing engineering, women engineers were asked to rate 16 items related to the motivational theories. The results revealed *Professional Growth* as the most powerful motivator for enrolling in the engineering major, followed by *Financial Growth*, *Social Growth* and *Personal Growth*. Such results are consistent with previous studies in Lebanon (Baytiyeh and Naja 2010) and in Europe (Béraud and Cooper 2005) showing that job satisfaction along with creativity are among the main factors motivating students in their choice of a major. Certain important factors fall under *Financial Growth* desires: the need for financial prospects and opportunities was shown to be an important contributor to students' choice of a major. This is also consistent with previous studies (Reha and Lu 1985; Wheeler 1983). However, salary does not appear to be a main incentive for engineering students in Europe (Béraud and Cooper 2005). Although *Professional Growth* and *Financial Growth* were statistically significant based on Bonferroni's method, this significance cannot be considered meaningful because the difference is not remarkable on a scale of 5. Such results suggest that both growth prospects contributed almost equally to these female students' choice of an engineering major.

One main objective of this research study was to examine the perceptions of females regarding the essential skills for a successful engineering career and to assess whether they were well prepared in college to succeed in their career. Participants were asked to rate 27 indicators reflecting *Technical*, *Interpersonal* and *Personal Skills* in terms of how well they were trained before graduation and how important these skills are for their professional success. Although the results reflect a sufficient emphasis on *Technical Skills*, it appears that these women engineers were not sufficiently prepared in college for 'transforming knowledge into product', to 'conduct experiments on their own', and in 'creativity and innovation skills'. Such results imply that females do not feel confident about their creative thinking. Previous research has shown that male students feel stronger than female students about their creative thinking and problem-solving skills (Besterfield-Sacre et al. 2001). The need for practical experience linked to self-confidence, especially in a male-dominated field, has been shown to be one of the main obstacles for female engineering students in Europe (Wächter 2005). Lack of application of theoretical knowledge has been shown to be a barrier for females pursuing a technical education and, therefore, women need more opportunities as students to apply their technical knowledge (Robinson and Reilly 1993).

Although women engineers considered *Technical Skills* important after beginning their careers, *Interpersonal* and *Personal Skills* are indispensable for their professional growth. The results show that these skills were somehow overlooked in college. The issues that posed the least problems for respondents were mostly communication-based: oral and written communication, working as a team member and communicating with colleagues. This supports previous research showing that women engineers tend to have good human-relation and verbal skills (Robinson and Reilly

1993). In Europe, over 50% of female engineering students supported the addition of languages to their current curriculum followed by soft skills (Dahmen 2005): in France, many of the women (77.5%) would like to learn more soft skills, as well as in Austria (67.6%) and Germany (57.4%).

The primary problems that respondents experienced were related to *Managerial Skills*. 'Motivating others for a given task', 'being willing to take risks', 'leadership and managerial skills' and 'knowledge of business and public policies' were the four biggest problems for female engineers. These problems are indicative of the difficulties associated with combining management and technical skills. We also note that among the respondents, none had specialised in engineering management, and only 21% of the participants held managerial positions. This implies that these participants have moved to these positions through gained expertise rather than their academic background. In an engineering career, most practicing engineers start moving to managerial positions after several years of experience. Koushki, Al-Sanad, and Larkin (1999) investigated attitudes in Kuwait towards gender bias among professional women engineers. The majority of women engineers expressed feelings of equality with, or superiority to, their male colleagues, except in opportunities to reach upper management positions. The WomEng project (Thaler 2005), which was designed and implemented in Europe, has confirmed that gender equality in the field of engineering has not yet been achieved. It was noted that this inequality is not limited to the departments and schools of engineering alone but also influences to the career paths and job profiles. 'In what way technoscience and its institutions can be reshaped to accommodate women?' Wajcman (2010) inquires about the role of gender in technoscience and believes that males dominate in many cultures through control of companies and industries, which inhibits women from succeeding in technical or scientific careers. Gender is fundamental to the culture of engineering organisations, where females have to gain male acceptance (Powell, Bagilhole, and Dainty 2009).

Ability to work effectively in a team was ranked as the most important element for a successful career, followed by confidence in dealing with others and making decisions and accepting responsibility. Besterfield-Sacre et al. (2001) showed that female engineering students exhibit lower confidence levels in their ability to succeed in engineering compared to male engineering students. More important for professional success than strong technical abilities were certain *Personal Skills* such as the ability to work well under pressure, manage time and plan.

Conclusion and remarks

This study sheds light on the status of women engineers in Lebanon as a case study for the Middle Eastern Region. The survey attempted to understand females' perceptions from enrolment in engineering colleges through practice of an engineering profession. A personal interest in the subject matter appeared to be the leading influence in students' decisions to enrol in engineering. Participants indicated a strong need for a profession with earning potential and opportunities for promotion. Moreover, the results showed that female engineers possess sufficient theoretical and technical skills, but report themselves as weaker in creativity and innovation. Nonetheless, interpersonal and personal skills, mainly in leadership and management, were the skills most overlooked in college, despite their importance in work settings. These findings suggest that engineering programmes should implement training in leadership and management to bridge the gap between schooling and practice.

The results show that women engineers in Lebanon are underrepresented. This is most likely due to the lack of support from both parents and social organisations. Therefore, women are left to struggle in a male-dominated environment. The number of males enrolled in engineering programmes at the public Lebanese University within the last six years is three times greater than the number of females. Furthermore, the number of male engineering students in private Lebanese universities is six times the number of female engineering students. This fact requires further investigation to determine whether sons and daughters, in this culture, are given equal opportunity to pursue a degree in engineering. In addition, the finding that 20% of the participants would not choose engineering as a profession again requires further examination to uncover the reasons behind such an attitude.

Further efforts are needed to make technically oriented careers more attractive to women. Women engineers should initiate engineering associations with goals that address the following:

- Encouraging women to enrol in engineering programmes.
- Supporting women in engineering studies through internships and scholarships.
- Conducting workshops and seminars that focus on specific areas such as management.
- Assisting women engineers in finding positions.
- Assisting women engineering graduates in the transition from college to work.

Although this paper enlightens schools, colleges and universities, professors and engineering firms about the present status and future possibilities for women engineers, more studies, perhaps in other geographical regions of the Middle East, are needed to support these findings. Finally, an examination of the perceptions of employers would shed light on other challenges facing novice women engineers.

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