A Survey of Kuwait's Demand for Industrial Engineering Graduates*

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The program of industrial and systems engineering was recently established in Kuwait. The objective of this study is to predict local market needs for industrial engineers and to determine the extent to which industrial engineering areas are applied in Kuwait's industrial and service sectors. A survey instrument was designed to accomplish this objective and covered five main areas of industrial engineering. The survey was administered in six industrial sectors, namely, oil/chemical and plastic, construction, processed metals and equipment, paper, agricultural and foodstuffs, and the service industry. Content validity of the survey instrument was established by the industrial engineering faculty at Kuwait University. Results revealed that current and future overall demand for industrial engineers is low. The use of multiple linear regression revealed only two areas in which industrial engineers are in high demand. Individual analysis of each local sector was examined to assess the extent to which the industrial engineering discipline applies.

INTRODUCTION

INDUSTRIAL ENGINEERING'S (IE) systematic approach to solving problems can be applied successfully in all areas of a company's operations. It is a discipline that is concerned with the purpose of integrating people, machines, and industrial processes for improved overall effectiveness—it integrates basic engineering, economics, ergonomics, and behavioral science principles to develop and maximize the effectiveness of work. Industrial engineers (IEs) practice in all phases of manufacturing industries, service industries, and government agencies and are very flexible and can move around and thereby improve their utilization in a number of different areas/jobs. IEs are essentially impact engineers with IE 'skill sets' who are able to very effectively work across an organization, bringing together those with diverse skills in design engineering, sales/applications engineering, manufacturing engineering and management, quality management, operations management, information technology, and finance management in order to solve problems and implement their solutions.

Almost all characteristics of IE operations are common across manufacturing industries, whereas others are highly specific to the particular industry segment they occupy, specifically in the case of service industries and government agencies. Although the IE discipline covers a wide range of topics, for the purpose of this research five main areas are suggested to cover the IE spectrum, these are:

- applied operations research;
- ergonomic/safety/job design;
- statistical applications and quality control;
- manufacturing/production/inventory control;
- engineering management/work measurement/engineering economics.

Even though the activities of IE have been used in local industries, the IE field itself is very new to Kuwait. In 1994, for the first time the program of Industrial and Systems Engineering was established in Kuwait University under the Department of Mechanical and Industrial Engineering and a total of 7 students were among the first group to graduate from this program in the spring of 1998. Only Kuwaiti nationals are accepted in Kuwait University's undergraduate engineering programs.

Currently, a total of 400 IEs are working in Kuwait industries of whom 45% are Kuwaitis, most of whom have graduated from American universities [1]. Out of the Kuwaiti IEs employed, 7% are female. Table 1 shows the number of different kinds of engineers employed in Kuwait from 1994 to 1997. Chi-square test revealed that for each kind of engineers, the total number employed did not vary significantly during the four years ($\chi^2 = 6.17$, d.f. = 12).

Kuwaiti IEs have gained the knowledge and necessary skills needed to contribute to the profession and their exposure to the latest technological advancements have helped them to be on par with their peers elsewhere. The main challenge was to determine the extent to which IE applications are practiced in local industries, the future outlook market demand for IEs and the actual support needed from graduated Kuwaiti industrial engineers. The objective of this research was to predict local job market needs of IE areas and to look in greater detail into each industrial sector's market needs of certain IE areas.

Table 1. Total number of various kinds of engineers employed in Kuwait (1994–1997)

	1994	1995	1996	1997
Civil engineers	2164	2467	2625	2902
Electrical engineers	2038	2313	2514	2811
Mechanical engineers	1513	1717	1902	2110
Chemical engineers	322	354	403	481
Industrial engineers	287	345	380	400
TOTAL	6324	7196	7824	8704

METHOD

A survey instrument was developed which consisted of major activities and techniques encountered by industrial engineers. Initially a total of 29 items that reflected activities of the IE field were included in the questionnaire; such items were carefully selected from the literature [2–4] and were finalized by the experience of the author and then validated by input from Kuwait University's IE faculty. Validity of an instrument is defined as the determination of the content representativeness or content relevance of the elements/items of an instrument by the application of a judgment process [5]. Five IE faculties from Kuwait University, one expert from each area, were asked to assist in determining whether the items and the entire instrument are content valid. Feedback from the faculty proved useful in clearing up item terminology and eliminating any redundancies among items to properly reflect the scientific merit of the IE area. The 29 items were reduced to 13 and were included in the final form of the survey instrument to comprehensively represent IE applications at the macro-level.

Selected items of the industrial engineering field at the macro-level used in the survey:

- *Applied operations research:* techniques are used to allocate scarce resources (labor, capital, machine) to maximize profit and minimize costs; OR techniques are used to estimate and control the time required to complete a project.
- *Ergonomic/safety/job design:* techniques are applied to match job requirement (physical, mental, environmental demand) to workers' capacities; techniques are used to optimize workers safety and reduce accidents.
- *Statistical applications and quality control:* experimental simulation techniques are applied to systems; quality of manufactured product is monitored using QC techniques.
- *Manufacturing/production/inventory control:* techniques are used to monitor production levels and optimum inventory levels; techniques are used to ensure the right distribution of products/services.
- *Engineering management/work measurement/engineering economics:* feasibility techniques are used to determine the present/net worth of products/services; techniques are used to determine the standard time for completion of jobs/tasks.

Another section of the survey instrument was established to obtain certain information and contained three questions: 'Approximately, how many IEs are currently employed in your company?' 'Do you expect to hire IEs in the next year or so? If the answer is yes approximately how many?' and 'Do you think that IE principles and practices can significantly add value to your company?' This last question was used as the criterion (dependent) variable in multiple regression, with the predictors being the five IE areas. Responses on the criterion variable were measured using a five-point Likert scale with a score of 5 representing strongly agree and a score of 1 representing strongly disagree.

To achieve the objective of the study, the survey instrument was administered to local manufacturing as well as service industries since IEs can uniquely make valuable contributions in both industries. Manufacturing industries in Kuwait are classified into nine sectors according to International Standard Industrial Classification (ISIC) by the Ministry of Commerce and Industry [6]. These are: mining, agricultural and foodstuffs, textile, woodworks, paper, chemical/oil and plastic, construction, heavy metal, and processed metals & equipment. Local manufacturing companies targeted for this research were crown companies (fully owned by the government) and joint companies (proportionally owned by private and government sectors) since these companies are well established and the government requires that such companies annually hire a certain percentage of Kuwaiti nationals. Kuwait's industrial private sector is relatively small both in size and in industrial applications and was disregarded from the survey.

A sample of manufacturing industries was selected from a total of 20 local crown and joint companies established in Kuwait. To obtain an adequate sample, the names of all crown and joint companies under each of the nine sectors of the manufacturing industries were put into an alphabetical list and assigned numbers. However, four industrial sectors did not contain any crown or joint companies and were disregarded from the analysis. These were: mining, textile, woodworks, and heavy metal.

By the use of a randomized sampling table a sample of 13 companies was selected. Due to differences in the number of companies under each sector, the sample contained 3 companies from agricultural and foodstuffs, 2 from paper, 3 from chemical/oil and plastic, 2 from construction, and 3 from processed metals and equipment. In addition, 2 service industries which are well established and highly business oriented and employ a large number of Kuwaiti nationals were also selected and included in data analysis (Table 2).

Table 2. Local crown and joint companies established in Kuwait (*samples selected for the survey)

Classifications	Companies
1. Agricultural and foodstuffs	• Livestock transport and trading co.*
	• Kuwait united poultry co.*
	• Kuwait flour mills & bakeries*
2. Paper	• Carton industries co.*
	• Kuwait paper products mfg co.*
3. Chemical/oil and plastic	• Kuwait national petroleum co.*
	• Kuwait oil company*
	• Petrochemical industries co.*
	• Kuwait oil transport co.
4. Construction	• National industries co.*
	• Kuwait company for process plant construction & contracting*
	• Kuwait building materials mfg co.
	• Kuwait cement company
5. Processed metals and equipment	• Kuwait metal pipes industries*
	• Kuwait shipbuilding and repair yard co.*
	• Refrigeration industries co*
	• Kuwait American air conditioning
6. Service industry	• Kuwait airways*
	• Mobile telecommunications *

Each survey was answered by two individuals from each industry, a general/human resources manager to answer questions related to the company's current demand and future support needed from IEs, and a staff supervisor (a person involved in the major thrust of business activities and posses technical knowledge of industrial applications) to answer the questions related to IE practices and applications. Arrangements to contact the concerned persons were made previously by phone and a personal appointment was then taken. It was emphasized to the individuals that this survey was not an assessment of the company but served only for research purpose and completion of the questionnaire is voluntary, all individuals selected agreed to participate.

RESULTS

Responses of human resources managers on the number of IEs employed and future demand needed from Kuwaiti-graduated industrial engineers will be presented first and then multiple regression analysis will be utilized to predict local job market needs of the five main areas of IE.

Demand for IEs in Kuwait industry

For fifteen (n = 15) total companies included in this study, almost all human resources managers (92%) who responded to the survey were male and over three-quarters (77%) were Kuwaiti citizens. Their age range was evenly divided between 36–45 and 46–55 years. About two-thirds (63%) of the companies surveyed had less than four IEs employed, 15% had 4 or 5 IEs, another 15% had over 5, and 7% of those companies had no IEs working for them. Regarding the second question, 'Do you expect to hire IEs in the next year or so?' only 31% of the respondents said definitely 'Yes', 22% said definitely 'No', and the remaining half (47%) responded 'Maybe'. Of those who responded 'Yes', an equal percentage of them stated that they would probably hire either 1 to 2 or 3 to 4 IEs.

IE areas mostly practiced in Kuwait industry

This section will present two analyses; first, multiple regression will show which of the five predictors of the IE area will contribute most to successful prediction of the local market need of the IE area.

The use of stepwise and backward selection procedures in multiple regression both produced similar results. Out of the five variables, two were found to be good predictors of IE market needs. These are statistics/quality control and engineering management/work measurement/engineering economy. Under both selection procedures, the multiple R was 0.875 (significant at the 0.01 level) which accounted for 76% of the variance in the criterion variable. Table 3 summarizes the results. The first predictor to enter the equation in stepwise multiple regression was engineering management which accounted for 32% of the variance (F = 5.308, $p < 0.05$), statistics was entered second with an additional 44% of the variance (F = 16.246, $p < 0.01$).

Next, each of the five main areas of IE were looked at to assess the extent to which they are applied in each of the six local industries selected: agricultural and foodstuffs, paper, chemical/oil and plastic, construction, processed metals and equipment, and the service industry.

Scores on the items for each IE area were divided into two parts: 'always' and 'frequently' were merged to represent a response of 'often', while 'rarely' and 'never' were merged to represent a response of 'rarely'. The following is a closer look of IE applications in each of the six local industries selected. Figure 1 shows IE practices in the six local industrial sectors.

Table 3. Multiple regression summary table for the stepwise selection procedure (the prediction equation is Y = 4.18 + 2.18 Manag. – 2.27 Stat.)

	MultR	Rsq	F(Eqn)	SigF
Step 1	0.5705	0.3255	5.308	0.042
Step 2	0.8745	0.7647	16.246	0.001

- *Agricultural and foodstuffs.* From Fig. 1, it appears that nearly all IE areas are practiced very often in this industry. However, the use of statistical applications and quality control techniques are only moderately applied (78%).
- *Construction.* It appears from Fig. 1 that the two companies surveyed within the construction industry both fully utilize IE techniques and practices. The area practiced least was engineering management/work measurement/engineering economy.
- *Chemical/oil and plastic.* Similar to the construction industry, Fig. 1 reveals that the chemical industry very often applies to all IE areas. However, engineering management/work measurement/engineering economy are not widely used.
- *Paper.* Both companies within this industry reported that all IE areas are widely used and very often applied.
- *Processed metals and equipment.* Data analysis of the three companies surveyed within this industry revealed that three IE areas are often and broadly applied: ergonomics, manufacturing, and engineering management. On the other hand, operations research and statistics/quality control are used only moderately.
- *Service industry.* The service industry reported applying 'traditional' IE practices more often than non-traditional IE applications, such as ergonomics. Other studies reported similar results [3].

DISCUSSION

After liberation in 1991, the college of engineering at Kuwait University has been working with the Accreditation Board for Engineering and Technology (ABET) to organize and develop its engineering programs to be substantially equivalent to accredited engineering programs in the United States. Currently, all local engineering programs—civil, mechanical, and chemical—have been evaluated by ABET and found to be substantially equivalent. The industrial engineering program, however, which opened only in 1994, is following ABET standards and guidelines, but has not yet been evaluated by ABET.

This study was designed to uncover current local demand of Kuwaiti IEs in Kuwait's industrial and service sectors. The survey revealed that a very small number of IEs are currently working in Kuwait's industries. In addition, most respondents did not really have a clear plan or focused intention to hire more IEs. This issue is of immediate concern, given the relatively small industrial market of Kuwait and the growing number of graduating Kuwaiti IEs.

Sampling only crown and joint companies is not considered to be a limitation of this study since the private sector is relatively limited in both size and industrial applications and hires mostly foreign employees to cut down on labor costs. Therefore, it is viewed and expected that the private sector is not a hiring market for newly graduated Kuwaiti IEs. However, the sample of industrial companies selected for this research is small (n = 15), especially given the use of multiple regression with 5 predictors. According to Stevens [7], about 15 subjects per predictor are recommended for a reliable equation to cross validate if applied to an independent sample from the same population. Nonetheless, it should be pointed out here that a very high percentage (75%, or 15 out of 20 total) of
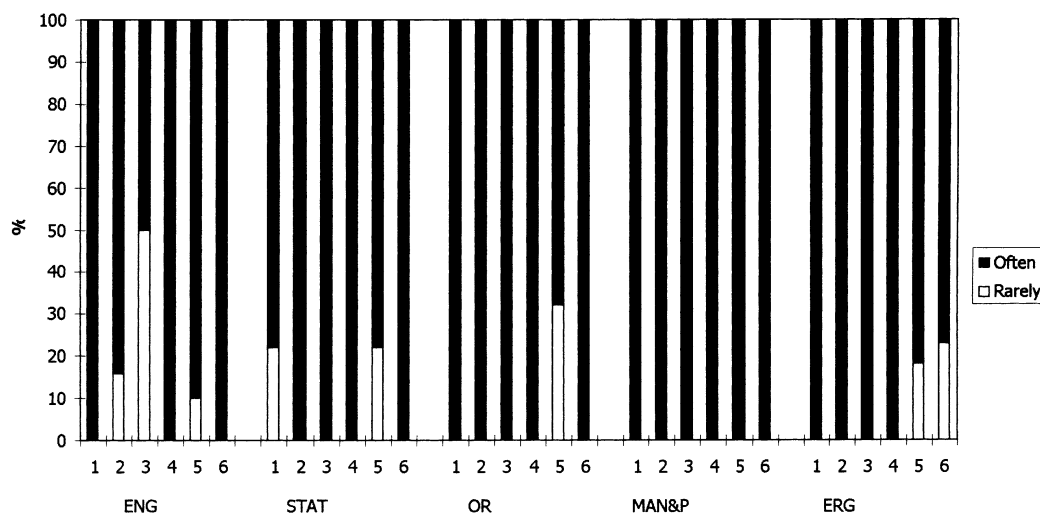
Fig. 1. Percentages of each industrial engineering area practices in the six industrial sectors in Kuwait. Note: 1 = agriculture, 2 = construction, 3 = chemical/oil, 4 = paper, 5 = processed metals, 6 = service.

Kuwaiti industrial companies are sampled. Thus, the findings of this study can be generalized and considered representative of Kuwait's industrial and service market sectors. It was found that two out of the five IE areas, namely engineering management and statistics/quality control are good predictors of Kuwait's industrial market needs.

This interaction between academia and industry strengthens the mutual benefits as both are dependent on each other. Feedback received, could help fuel the growth of the IE department and help in focusing the thrust of the department's curriculum. Unfortunately, no mechanism currently exists that would allow for these survey results to be implemented into Kuwait's educational programs. However, the results could be used for human resources or manpower planning at the ministry level in Kuwait where circulation of these findings may have greater impact.

Finally, the low demand for industrial engineers here in Kuwait is curious, given that demand in the rest of the world appears to be so healthy. However, this may be due in great part to the small and underdeveloped private sector in this country, which limits demand for skilled engineers of all types. If so, the supply of industrial engineers will likely exceed market needs for many years to come as public sector policies continue to hamper private sector development.

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