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EXPLORING ENTERPRISE SYSTEM ENGINEERING SKILL GAPS IN THE LABOR MARKETS OF EGYPT AND TUNISIA

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Abstract. The proposed research is driven by an existing need to develop a master programme in enterprise system engineering (ESE) to the Arab Universities. The main objective of the project is to ensure the development of a top-notch curriculum that comprises the latest technology and teaching methods while integrating the local labour market needs of the target countries. To achieve that, a labour market analysis in the ESE domain is conducted in this proposed research. The study is divided into two main parts, one is qualitative to uncover several issues in the labour markets of the target Arab countries relevant to ESE and the second part is quantitative designed to measure the skill gaps prevalent in those countries to which the master programme is exported. Besides the business problem calling for this research, its importance is leveraged by the strong evidence in the literature showing that supply and demand skills rarely match. This research is expected to explore and measure potential gaps between employment and education in ESE, a point that is crucial for more efficient education and employment in the Arab countries.

Keywords: ESE, skills, gap, curriculum, enterprise, system, engineering, market, labour competencies.

JEL Classification: I23.

1. Introduction

Employability and skill development are major concerns for governments and organizations in all sectors and universities. Countries and organizations tolerate the high cost of either shortages or employees lacking in the right skills for critical jobs. According to Dobbs *et al*. (2012) in McKinsey Global Institute report, a potential global shortage of around 38 million of high skilled and 45 million of middle-skilled employees, is expected in 2020. The problem is further compounded when unemployment rates are high and companies are striving to find the right talents equipped with the 21-century skills to fill their job vacancies. Therefore, the importance of developing and nurturing the required skills by preparing highly qualified calibers with qualifications that match knowledge-based and high technology labor market is unquestionable at international, national and institutional levels. This research is an initial stage of a major project "Exporting Master Programme in Enterprise Systems Engineering (MSC.ESE)" in which a curriculum is designed in conformance to the European Credit Transfer System and Bologna Process. In order to initiate the curriculum development, some inputs need to be included to ensure meeting European standards of education and meanwhile address the needs of the local labor markets to which the curriculum is delivered. To achieve this, it was important to employ a holistic review of current situation that in turn called for exploring the labor market needs in ESE and information systems domains. For this reason, the current research is conducted as an initial a step towards the curriculum design of the MSC.ESE. Figure 1 illustrates the role of the research in the overall process.

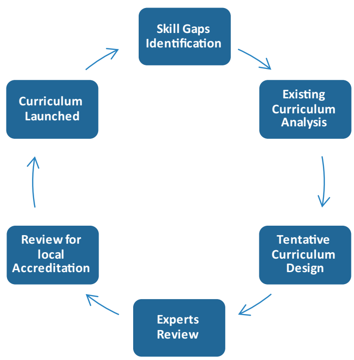

Fig. 1. Curriculum development process

Since the curriculum sustainability is of paramount importance, the process doesn't stop at curriculum design but it is continuous to ensure alignment with scientific development and market changes. Seymour and Luman (2011) suggest that the perception and fields of systems engineering are dynamic, requiring continual attention to the curriculum. The current research has three main objectives that are identifying the key jobs, exploring the challenges faced by workers in ESE and Business Information Systems domains and measuring skill gaps currently existing in the labor market of the target countries. This study is expected to provide future academic direction for an advanced curriculum that addresses the local market needs of Arab countries.

2. Literature review

International Council on Systems Engineering Haskins (2011) defines enterprise systems engineering (ESE) as "a discipline that focuses on design and implementation of whole systems, an iterative process of top down synthesis, development and operation of a real world system and as an approach to enable realization of successful systems". To conduct the abovementioned activities of ESE, a major high order thinking skills is essential. Frank (2010) asserts the role of systems thinking as a high order thinking needed by systems engineer. Systems engineering is still a young and evolving domain Valerdi, Davidz (2009) yet it encompasses a wide spectrum of different jobs such as system designer, system analyst, process engineer, customer interface, logistics, integration, project management and others (Eisner 2008; Frank 2010; Sheard 1996). The various jobs entail a variety of skills and knowledge areas. Derro, Williams (2009) assert the identification of the literature of skills and jobs required by successful systems engineer. According to Lih (1997) several years back, industry leaders were still calling upon educators to provide a holistic education that addresses systems thinking and strong interpersonal skills.

According to Senge (1990), systems thinking is about the ability of seeing the whole picture and all other aspects of a system. In a systems engineering, this would entail the ability to perform systems engineering tasks including examining and analysing the situation, developing a concept for operation, conceptualizing and generating a logical system using simulation for optimizing solution and finally implementing systems design considerations based on (Davidz, Nightingale 2008; Haskins 2011). These are the typical tasks required to perform the core engineering business process and can be categorized under core business process set. A high capacity engineering systems thinking is a necessary ability for a successful system engineer. Engineers with better systems-thinking capabilities are critical in organizations and need to be identified, selected and placed for jobs requiring a Capacity for Engineering Systems Thinking (CEST) based on Frank, Zwikael and Boasson (2007).

There are several models identifying the competencies of a successful systems engineer. Successful systems engineers are aware that non-engineering issues are to be considered as well. This is confirmed, if not overemphasized, by The Jet Propulsion Laboratory (JPL) competency model presented by Jansma and Jones (2006) which asserts personal behaviours and divides those behaviours into five groups including, leadership, communication, attitudes, problem solving and systems thinking, and technical acumen. The maturity model framework developed by Kasser *et al*. (2009) had provided a more balanced approach that reflects an almost equal importance level among different categories of skills. Maturity model encompasses three broad areas, which are individual traits, knowledge of systems engineering and cognitive characteristics. The three areas refer to the ability to think and tackle problems in both conceptual and physical domain. A popular and widely used CEST competency model presents a 16-cognitive competencies list that is related to systems thinking. Many other systems engineering competency models exist in the literature such as systems engineering competency taxonomy introduced by Squires *et al*. (2011), generic competency model and NASA systems engineering competencies NASA (2009).

Systems thinking is the core for successful performance of enterprise systems engineering and due to evidence of successful use of CEST model as competencies assessment tool with high validity and reliability measures for systems engineers, the capacity for enterprise systems thinking (CEST) model is adopted as one of the main inputs for the current study questionnaire. Additionally, the maturity model framework is adopted to categorize various skill sets to be evaluated into the three broad categories.

3. Methodology

This section provides a description of the research data, measurement and methods employed in the data analysis. The current study adopts quantitative and qualitative approaches to data collection. A qualitative approach that most frequently researchers adopts to deal with capacity for engineering systems thinking may be insufficient due potential subjectivity Frank and Elata (2004).

3.1. Measurement

A questionnaire is developed to answer research questions. The questionnaire is divided into three main parts. The first part includes semi-structured questions to gain practical insights from practitioners about key jobs, skills needed, skills envisioned, and challenges holding performance within enterprise systems engineering and/or information systems realm. The second part is designed to identify and measure the magnitude of the skill gaps existing using a five point Likert scale that measure the relative importance and the perceived current performance for each skill driven from the literature as being relevant to system engineers. Final part includes demographic information about the respondents' companies surveyed. The dimensions and items in the questionnaires are adopted from two models namely 1) maturity model framework where three broad areas are important for the development of enterprise systems engineers specifically knowledge, cognitive characteristic and individual traits 2) capacity for engineering systems thinking (CEST). The reason this model is chosen is that it elaborates on systems thinking by including several elements that can be assessed. The overall internal consistency reliability of the scale is relatively high ($\alpha = 0.85$). Construct reliabilities measures ranges between ($\alpha = 0.72$) and ($\alpha = 0.87$). Sekaran, Bougie (2010) pointed out that the closer the Cronbach alpha is to "1", the higher the internal consistency reliability. Generally, reliabilities less than 0.6 are considered to be poor, those in the 0.7 range, acceptable, and those over 0.8 good. Thus, the internal consistency reliability of the measures used in this study is acceptable.

3.2. Data collection

Data is collected from companies operating on the territory of the target countries. Middle and top management are key informants since the evaluation of supervisors and management is expected to be a valid information source additionally, they can influence firms' strategic choices and are the units mostly aware of the organization's systems and processes. According to Duarte (2010) it is well noted in the literature that managers would ultimately affect a firms' practices. Therefore, middle and top managers from information and communication technology domain are the sample units. From each country, 30 valid questionnaires were collected. Rosce (1975) proposes that sample sizes larger than 30 and less than 500 are appropriate for most research.

A total of 87 questionnaires were filled and only 60 were included in the study and regarded as valid observations. A number of 20 questionnaires are excluded due to missing data and other questionnaires collected from a third Arab country with insufficient sample size. When 25% of the items in the questionnaire have been left unanswered, the questionnaire is discarded as suggested by Sekaran and Bougie (2010). All items in the survey were checked to ensure validity and exclude the items not sufficiently answered. Qualitative responses were analysed using content analysis while other variables are coded and entered into the Statistical Package for Social Science (SPSS). The sample consists of companies from a variety of sectors including major players in these sectors in information and communication technology (ICT) and manufacturing. The respondents are mostly from multinational companies who are experienced practitioners in the area of information systems and capable of providing an expert opinion to ensure that their perception counts.

4. Data analysis and results

4.1. Sample characteristics

The sample characteristics are described based on the companies' sectors, number of employees, annual revenue, information system used and ownership. A relatively large percentage of responding organizations are governmental entities such as ministry of environment, ministry of communication and information technology, Tunisian electricity and Gas Company, urban rehabilitation and renovation agency among others. The majority of companies surveyed are medium and large companies. The majority of companies in Egypt and Tunisia use Oracle and Microsoft. Only 10% of the sample in Egypt uses SAP and 9% in Tunisia. Some companies use several systems simultaneously.

4.2. Descriptive statistics

4.2.1. Key jobs

Respondents are asked to identify top five jobs that are considered crucial for the success of the organization they work in.

The most three key jobs common between Egypt and Tunisia (see Fig. 2) are business developer, systems developer and quality control while project manager is having a high percentage of responses in terms of being a key job. Other miscellaneous key jobs were classified as non-engineering including finance, human resources and marketing. Figure 3 reflects the percentages of responses from the two countries for key non-engineering jobs.

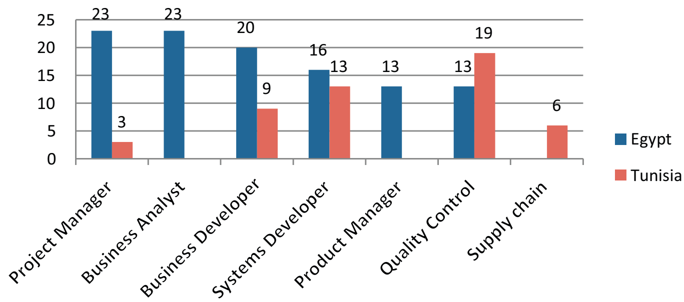

Fig. 2. Key engineering jobs in Egypt and Tunisia

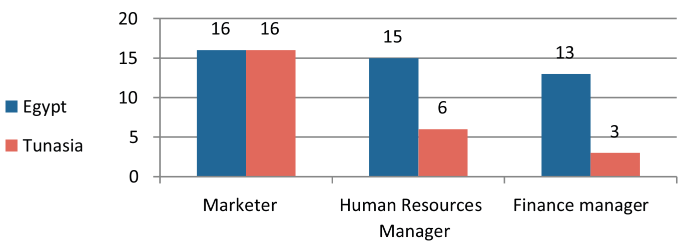

Fig. 3. Key non-engineering jobs in Egypt and Tunisia

4.2.2. Skills and knowledge area envisioned by practitioners

Respondents were asked to envision some of the skills and knowledge areas that practitioners aspire to finding in their teams they are responsible. Qualitative responses are classified into engineering (Fig. 4) and non-engineering skills. Non-engineering skills are further classified into management science (Fig. 5) and soft skills (Fig. 6) that are elements related to attitudinal and behavioural aspects.

4.2.2.1. For engineering skills, the most frequently mentioned knowledge areas in both countries are applying latest engineering technology and understanding different business processes while both countries differ in the priority of third engineering knowledge area envisioned by practitioner. Egypt practitioners aspire for the development of engineering R&D of the Masters holders while in Tunisia information systems need development.

4.2.2.2. Non-engineering knowledge areas are classified into management sciences and soft skills. Both countries mentioned the same areas with slight difference in priorities regarding the management science and soft skills areas.

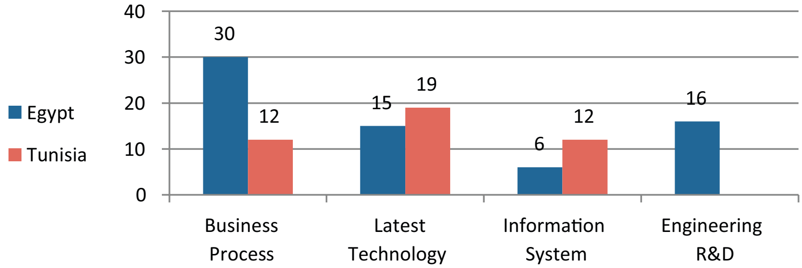

Fig. 4. Key engineering' knowledge areas

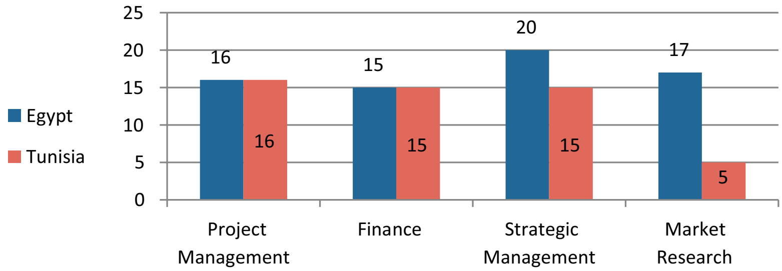

Fig. 5. Key management's knowledge areas

Strategic management responses encompasses the non-engineering key jobs mentioned previously including marketing, finance and human resources that are different functional areas addressed in strategic management. The other management science areas that practitioners envision are relevant topics in a typical strategic management course. When analyzing qualitative data, knowledge areas relevant to strategic management are intentionally categorized as independent areas to focus the attention on the relatively high frequency of occurrences in practitioners' responses.

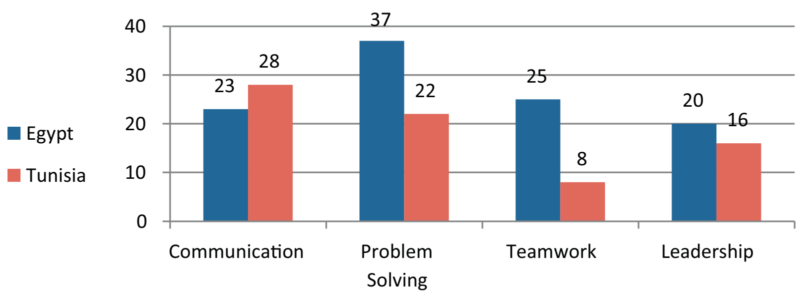

Fig. 6. Key soft skills areas

4.2.3. Challenges hindering performance

Responses received when asking managers current performance hindrances for their teams are categorized into three main areas that are core business process, management, soft skills. This part is expected to provide specific issues that managers are currently facing as issues that are hindering performance.

Table 1. Challenges hindering performance in Egypt

No	Core Business Process	Management	Soft Skills
1	Understanding enterprise systems interdependences	Lack of financial knowledge	Lack of independence in problem solving
2	Analysing technical problems	change management	Problem diagnosis
3	Scoping the project	Adherence to traditional practices and resistance to change to existing systems.	intercultural communication
4	Different design process	Lack of knowledge of other functions	Lacking the ability to work in teams
5	Practical Implementation	Achieve high users' satisfaction level with the provided solution expected	Positive interactions with others
6	Conceptualizing optimum solution		

Table 2. Challenges hindering performance in Tunisia

No	Core Business Process	Management Science	Soft Skills
1	Development of security systems	Decision making	Problem solving abilities
2	Information System Design	Corporate governance	Lack of autonomy in problem solving
3	Internet based programming methods	Resisting change	Lack of information sharing
4	Developing innovative information technologies	Lacking knowledge in Management	Timely and accurate communication

Based on the information in Tables 1 and 2, it can be deduced that there are common challenges facing Egypt and Tunisia and few differences exist in the core business area's challenges. Challenges related to core business process in Egypt exist through the technical process for system development starting from the analysis part until the conceptualization and implementation of a solution practically. Therefore, an overall skill enhancement and practical implementation should be among priorities for tutors addressing technical courses in Egypt. In Tunisia, there are much more specific challenges related to security systems and internet based programming methods. Challenges classified under management science and soft skills are common in both countries.

Three components of qualitative research are highly aligned which reflects the degree of consistency in practitioners' responses (Fig. 7). Challenges hindering performance responses can be overcome if the knowledge areas specified by practitioners are addressed in the curriculum. Additionally, areas of knowledge suggested are relevant

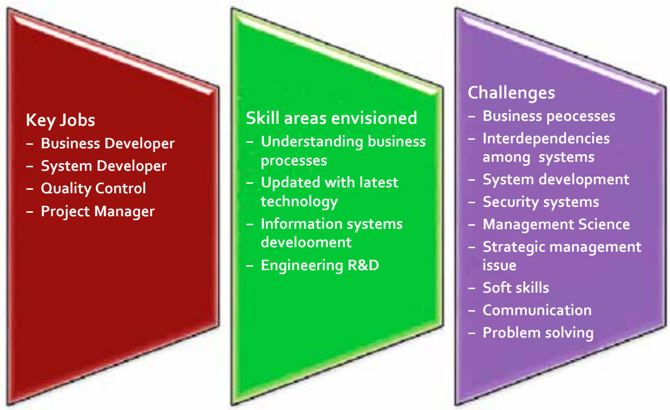

Fig. 7. Qualitative research findings

to the jobs identified as key jobs. After conducting the above exploratory research, the researchers can ensure that the skill set required in ESE domain by practitioners in both countries, can be grouped into meta-categories aligned with ESE literature. Dierdorff *et al*. (2009) has coined managerial competencies taxonomy comprises conceptual, interpersonal and technical/administrative work role requirements that can be seen as equivalent to the management skills, soft skills and engineering skills. Qualitative research findings are aligned with the Capacity for Engineering Systems Thinking (CEST) model. Accordingly, the identification of skills gaps and quantitative measurement can be conducted in light of CEST model.

4.2.4. Skill gaps

The following part represents the quantitative research designed to identify and measure skills gaps in the market from business practitioners' perspective. Hawkins *et al.* (2013) have conceptualized a gap as the difference between a desired state and an actual state. In the research context, the desired state is a function of the relative importance of the skill from the practitioners' perspective and the actual state is the practitioners' evaluation of the perceived current performance of his team. A skill gap is defined as the difference between the relative importance of the skill and the perception of current performance on that skill. Respondents were asked to rate on a scale of "1" (totally unimportant) to "5" (very important) the extent to which this skill has a high relative importance and to rate on a scale of "1" (very poor) to "5": (excellent) the extent to which the manager perceive the level of competence of his team on that skill.

4.2.5. Descriptive statistics

Descriptive statistics, including means, standard deviation, coefficient of variation, and rank for all variables are used. Mean values can be judged as high or low based on the frequency distribution rational and a standard can be set as follows:

Interval	Direction
1.00–1.79	Tends to strongly disagree
1.80–2.59	Tends to disagree
2.60–3.39	Tends to be neutral
3.40–4.19	Tends to agree
4.20–5.00	Tends to strongly agree.

4.2.6. Egypt and Tunisia skill gaps

When analyzing the relative importance and the perceived current performance of the three set of skills identified namely general skills, engineering business process skills and cognitive skills, it is found that the widest gap is in general skills constituting (37%) of the relative importance of the skill, followed by cognitive engineering skills (35.43%) and then engineering business process (33%). Meanwhile general skills set have the highest relative importance when compared to other two skill sets.

General skills has the highest relative importance and the narrowest skill gap compared to other skill gaps meanwhile, as in Egypt, the magnitude of difference among the three skill gaps is narrow.

The skill gaps as a percentage of the relative importance of the three skill sets are relatively high for both countries (Fig. 10). The differences between the skill Gaps in Egypt (Fig. 8) and Tunisia (Fig. 9) are slightly lower which entail that almost the same level of effort need to be exerted for these gaps to be filled.

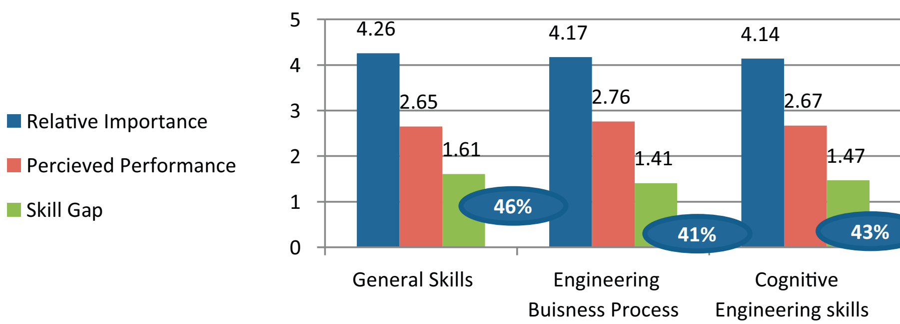

Fig. 8. Egypt skill gaps sets summary

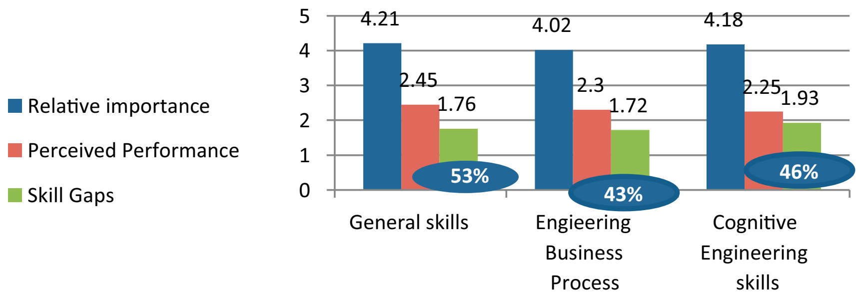

Fig. 9. Tunisia skill gap summary

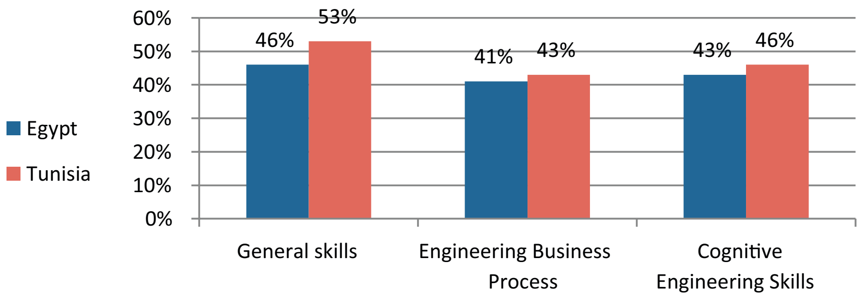

Fig. 10. Egypt and Tunisia skill gaps summary

5. Findings and discussion

Part one of the study is qualitative that is designed to bring in some insights directly from practitioners in the field and second part is quantitative to identify and measure the magnitude of skill gaps. The skills driven from the qualitative part is aligned with the literature. Additionally, the mean value of the relative importance for all skills in the quantitative questionnaire is >3.5 indicating that skills included in this study are all accepted and perceived by practitioners as necessary skills for enterprise systems engineers. Meanwhile, the mean value for perceived performance is <3 which indicates practitioners are currently not satisfied with current performance level of their teams on the skills that proved highly important for their jobs. Based on the current research questions (RQs), the following findings are attained.

5.1. Key jobs, skills envisioned and challenges hindering performance

Practitioners in Egypt and Tunisia identified four jobs as key namely business developer, systems developer, quality control and project manager. These jobs are consistent with the literature in terms of an essential common aspect that is the necessity for developing a high capacity for systems thinking in these identified jobs. Engineering systems thinking involves multitasking, interdisciplinary knowledge. Emes *et al.*

(2005) highlighted some of these related disciplines are systems analysis, system dynamics (system developer), project management (project manager), control systems (quality control), supply chain management (supply chain manager), engineering, information technology, human resource strategy, marketing management, and various specialist engineering. Project manager job had a high frequency of responses as a key job in Egypt (23%) but in Tunisia only (3%). Kossiakoff *et al*. (2011) suggest that system engineers continually interact with project managers and project management process in complex projects and there is usually an overlap in activities and processes in terms of task definition, interaction with customers and risk management. Therefore, a project manager can be perceived as one of the key jobs that require a high order systems engineering thinking.

Skills envisioned are categorized under three main sets namely skills related to business processes, skills related to management science and soft skills. Haskins (2011) asserts that systems engineering is interdisciplinary by nature and therefore overlaps with both technical and human centered disciplines. Business processes and latest technology represent the technical aspect. Meanwhile, system engineers need to address organizational, political, control, personnel and other “managerial” aspects as suggested by Frank (2010), consequently envisioning a list of management knowledge areas (strategic management, project management, finance, market research) is consistent with the nature of the systems engineer job. Complex projects and systems always necessitate systems engineers in working together. Hence, teamwork is often required and it will entail possessing other interpersonal skills by systems engineers to work with others effectively as the soft skills highlighted in the qualitative part including communication, problem solving, leadership and teamwork. Rao (2010) emphasizes the soft skills role as those skills complement the hard skills in evolving students as successful professionals. The importance of management skills and soft skills identified by practitioners in Egypt and Tunisia is well noted in the literature. Practicing engineer will argue that “an engineer is hired for her or his technical skills, fired for poor people skills, and promoted for leadership and management skills” (Russell, Yao 1996). Author of the book People Skills Bolton (1986) suggests that 80% of the people failure at work is attributed to their limited ability to interact and relate to others in the workplace rather the lack of technical skills. It is worth mentioning that communication, problem solving and teamwork skills are considered among leadership skills. Among the leadership skills that are reported by Crosbie (2005) are collaborative/teamwork, communication, and presentation. Whetten and Cameron (2011) reported that among the skills that research identified as critically important for effective leadership are solving problems analytically, communicating supportively, and building effective teams and teamwork.

Challenges perceived by practitioners as currently hindering performance has confirmed points from previous questions and uncovered others. Qualitative research reveals that there is a need for systems engineering technical skills improvement in

Egypt with respect to all tasks involved in the process. The magnitude of improvement is expected to be highlighted in the quantitative part. Security systems and internet based programming methodologies are among the main points perceived to enhance performance in Tunisia. The need to develop innovative information technologies is aligned with the ability of applying latest technology mentioned earlier. The two countries share similar challenges that are aligned with the skills and knowledge areas practitioners in both countries have envisioned. Various areas of strategic management including change management, knowledge management, decision-making, corporate governance, financial knowledge have been mentioned. Soft skills deficiencies are more specific when addressed and stated as challenges by practitioners, for example, intercultural communication, communicating accurately and timely, lack of information sharing and lack of autonomy in problem solving, limited ability in problem diagnosis.

5.2. Existing skill gaps

This part discusses the quantitative results to provide more in-depth view of the magnitude of the skill gaps and potential ways for enhancement. Generally, the average difference in the magnitude of skill gaps between Egypt and Tunisia across all skills is relatively low (8.6%). Skill gaps are marginally higher in Tunisia reflecting that almost similar job designs and work environments exist in both countries.

Soft skills set have consistently been given a high relative importance in Egypt and Tunisia ($\bar{x}$ = 4.26, 4.21) yet skill gap magnitude is wide constituting 46%, 53% of relative importance for Egypt and Tunisia respectively. Farr, Brazil (2009) suggests that a blend of hard and soft skills is needed to ensure long term success and partly explains why current performance on those skills might be relatively low by pinpointing the need for formally developing key soft skills for young engineers and reflect the importance of those skills early in their careers. Relatively low perceived performance can be attributed to engineers' tendency to acquire soft skills on the job, referred to as "learning the oft skills the hard way" (Kumar, Hsiao 2007). The soft skills highlighted in qualitative and quantitative research are the same with the highest relative importance and widest skill gaps. The three top soft skills in terms of relative importance are communication, teamwork and problem solving and analytical skills that are again consistent with the qualitative part. Engineers are routinely required to write project reports and proposals. Tenopir and King (2004) highlighted that written communications require the ability to organize thoughts and communicate them effectively. Employers frequently identify the lack of team skills as a critical gap in the preparation of engineering students as noted by Prince (2004). Since Leadership skills have been stated in the qualitative research among the skills envisioned by practitioners and is conceptualized as comprising ten skills including communication, problem solving, and teamwork. The top three leadership skills that need attention based on the skill gap width are communication (42%), problem solving and analytical skills (38%) and teamwork (37.5%) of their importance level based on managers' responses. These results are consistent with other studies. For example, data from ASTD's member survey collected in 2012 shows that leadership skills are ranked as the highest areas for skills gaps where (54%) ranked leadership skills on top.

The three widest engineering business process's skill gaps in Egypt are documentation skills (40%), solution conceptualization (36%) and solution implementation (29%) of the skills' importance. While in Tunisia Examine situation and define the problem (48%), conceptualize solution (47%) and implementation and prove of concept (46%).

The broadest cognitive skill gaps in Egypt are understanding the system as a whole (43%), understanding the system from multiple perspective (38%), understand implications of proposed changes (37%) while in Tunisia understanding the system as a whole (53%), understanding implications of proposed change (54%), capable of autonomous and independent self-learning (48%). Both countries share two of the cognitive gaps. The difference in cognitive skill gaps between Egypt and Tunisia is in practitioners' evaluation of perceived performance of employees while importance level assigned is the same.

6. Conclusions

Skill gaps exist across the three sets of skills identified for enterprise systems engineering in Egypt and in Tunisia. The magnitude of the gap is relatively wide with a lowest value of 29% of the relative importance of the skill and reaches to 54% of the relative importance. When performance of current employees falls short of what managers aspire, this indicates two important points: from one side, the current educational programs lack the capability in graduating students that are equipped with the relevant skills needed by the labor market and at the required level of competence. From the other side, skills of high importance level are either overlooked or the current educational practices are ineffective in addressing and improving those skills perceived as highly important in enterprise systems engineering. Therefore, based on the research results, a substantial need for a multidisciplinary program became apparent in order to address the various skill gaps identified in the Egyptian and Tunisian labor market.

The researchers feel confident in these conclusions not only due to qualitative and the quantitative results, but because of the theoretical basis from enterprise systems engineering, enterprise systems education and education management fields. The current research is one of the channels for bridging the gap between the corporate and academic worlds, a blue print for designing a curriculum that incorporates the existing environmental factors prevailing in target countries and an initial step towards designing learning environment that is student, knowledge, assessment and community centered.

7. Recommendations

Based on the overall findings, there are similarities across countries in terms of the key jobs, the skills and knowledge areas envisioned by practitioners in the market, the relative importance across different skills and skill gaps existing. This justifies the development of a unified curriculum that could be slightly tailored to meet requirements of the regulatory bodies operating in each country.

The current study has implications regarding the master's program selection criteria, intended learning outcomes, content, teaching and students' assessment. It is important to disseminate research findings and recommendations to participants in the curriculum design and modules development phases.

As Frank *et al*. (2007) asserts that the capacity for engineering systems thinking is critical for successful engineers, and this capacity is a combination of knowledge, behavioral competencies and professional skills therefore it is strongly recommended to have a CEST assessment as one of the selection criterion and possibly a development-tracking tool through the master's programme.

7.1. Intended learning outcomes (ILOs)

The wide skill gaps identified calls for enhancing educational outcomes that can be affected through determining and achieving constructive and relevant learning outcomes. The intended learning outcomes (ILOs) based on meeting educational standards of Bologna process, meanwhile need to be aligned with the challenges revealed by practitioners, and the skill gaps identified in the current study. When developing the intended learning outcomes, each module developer need to address his module ILOs in light of the following broad objectives that need to be tailored for each module:

1. Be able to critically evaluate and synthesize various solutions to be introduced to the latest technology and realize alternative solutions to the same problems at hand.
2. Apply an integrated approach to organizational problems to develop students understanding of core business processes and business interdependencies.
3. Evaluate critically and synthesize recent research and professional literature on systems engineering to address the need for research and development skills in engineering and the additional challenge pertaining to alternative solutions.
4. Demonstrate and use systems thinking in conceptualization, integration and implementation of projects. This is expected to enhance technical engineering tasks and management skills required to get projects running and successfully accomplished.
5. Show understanding and be able to design, execute and participate actively in research or development projects to deal with new business issues within a team. This will provide an opportunity for practicing problem solving, communication and leadership skills within and among teams.

6. Be able to relate general theoretical ideas into industry or institutional problems. This capability will help in transfer of knowledge of latest technologies shared in classrooms into real practice. Capitalizing on the shared knowledge will also enable students to understand systems from multiple perspectives.

7.2. Content

Based on research findings, it is recommended to develop a Leadership skills module to address the relatively wide skill gap for a set of skills that proved to be of high relative importance. Module developer is expected to emphasize communication skills, teamwork and problem solving relevant to enterprise systems engineering beside other leadership skills. Specific issues such as autonomy in problem solving, communicating accurately and timely are to be addressed based on practitioners' feedback.

A tailored module on strategic management that focus on introducing organizations functional areas and their interdependencies, customer value and satisfaction in marketing session, change management, decision making, need to be an integral part of the strategic management course content. Additionally, it has been mentioned in the technical skills relating to the engineering business process the need to understand business interdependences. This entails introducing organizational functional areas and the way these functions interrelate and integrate from a business perspective.

Given that among the key jobs identified is: project manager (23%), among the knowledge areas that current managers envision in graduates is: project management (16%) and due to the nature of ESE in terms of being projects based, it is highly recommended to add to the curriculum a project management module that is designed to accommodate the multidisciplinary ESE approach.

Developing and maintaining systems and subsystems successfully call for quality assurance and control. Among the key jobs identified is quality control (19%). Therefore, quality management is recommended to be included in the curriculum.

Due to the dynamic nature of enterprise systems engineering and the explicit and expressed requirement by managers in the domain, it is highly recommended to have a session in each module in the curriculum on "latest in the discipline" to ensure that students in each module are capable of identifying the most recent developments and breakthroughs in the module they are learning.

7.3. Teaching methods

Team based activities is important as in practice system engineers work in functional and cross-functional teams. Additionally, team based projects can provide opportunities of practicing communication among and within teams and other leadership skills. This will promote collaborative learning environments but at the same time, individual responsibility is important for achieving individual autonomy and self-learning called for by managers in this study. Springer and Donovan (1999) posits that the entire course does not have to be team-based. Individual accountability need to be considered as well, as seen by the emphasis on individual accountability in cooperative learning Prince (2004). Class activities need to be tied to important module learning outcomes and also promote student thoughtful engagement as suggested by Wiggins and McTighe (1998) to enable students to utilize complex skills required for systems thinking. Since problem-solving skills magnitude is relatively wide (42% of its importance), therefore, there is an obvious need for problem-based learning (PBL) to provide a natural learning environment for enhancing problem-solving and lifelong learning skills. There is research evidence to prove that when PBL is coupled with coaching and instruction on problem solving skills, students' problem solving skills are significantly enhanced Prince (2004). PBL allows the use of any relevant knowledge from different disciplines to develop solution(s) to a problem. This is considered at the core of systems thinking essential for addressing the complexity faced in real corporate problems.

7.4. Assessment

In addition to summative assessment, formative assessments are of equal importance in this program. As formative assessments are a corner stone for the development of students' skills and the progress of their ESE projects. Providing frequent feedback to students uncovers their thinking and makes it visible to the student, the tutor and students' peers. Hence, it can guide modification and refinement in their thinking as emphasized by Bransford *et al*. (1999). Assessment need to be designed to measure and evaluate a systems' engineer capacity for engineering systems thinking and so exams and assessment tools are to be tailored accordingly.

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