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ICTRP

Education and Training for ICT in Egypt
Specialist Report

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1. Analytical Discussions and Findings

Advancements in technology invariably create new opportunities and change the way organizations do business. But unlike past innovations, the explosive growth of the Internet and the digital revolution are transforming the global marketplace at an unprecedented pace. Today, companies are creating products and services that are increasingly defined and enabled by their software content. With a worldwide business and market environment that demands more products at a faster rate, and with richer feature content, there is increasing demand for companies to generate, outsource, or integrate software into products and systems at a faster rate. The resulting need for skilled software engineers has far outpaced the ability of educational institutions to produce them which has led to a worldwide shortage of software engineers.

There are different types of software products: application and embedded. Examples of application software are word processing, spread sheets, accounting and payroll. Application software is simple and requires huge distribution channels in order to be profitable. Application software has become a commodity and there are many companies producing this type of software in Egypt. Embedded software on the other hand is used in many devices that we use in our daily activities. Examples of these devices are: televisions, videos, microwave ovens, watches, mobile phones, etc. Embedded software has very high level of complexity and has to built to specific manufacturer specifications. It also requires very high degree of reliability (99.99999%). Demand for embedded software has sky rocketed in the past [illegible] years. Shortage of highly-trained software engineers worldwide has become a major problem for ICT companies. These companies have been looking for places around the world to establish software centers. Egypt has failed to attract any of the ICT companies to establish a software center. Motorola tried to establish a software center in Egypt and never started due to lack of highly trained software engineers and non-existence of a Software Engineering Institute. A software center needs to have 300-500 of highly trained software engineers to be economical. Egypt has to invest heavily in training and educating software engineers that can work in embedded software applications.

Electronic commerce is the intensive application of information technology to enable, enhance, and facilitate business transactions. E-commerce describes Internet sales to end users (business to consumer) while e-business defines the enterprise-level transactions that occur between manufacturers and vendors, manufacturers and distributors, suppliers and retailers, between distributors and among business divisions. E-commerce technology creates a new infrastructure where consumer and business transactions can occur 24 hours a day, worldwide, in real time. The future of e-commerce has no boundaries in today's business because it spans the world. E-Commerce is one of the fastest growing areas in organizational and consumer transactions, and is transforming the way enterprises do business. Forrester Research predicts that the value of goods and services traded between organizations over the Internet will be $1.3 trillion by the year 2004. Egypt need to invest heavily in training and educating enough professionals that can work in e-business applications.

A. Problems and Issues

- Shortage of highly trained workforce at the introductory and advanced levels in ICT.
- Shortage of highly trained IT managers. The nature of information technology work and the explosive growth of the field has created opportunities for rapid career progression and salary advancement. The iterative and project-based nature of the work means experienced IT professionals will have increasing responsibilities in project management, planning, and coordination. Technical IT professionals need to acquire additional business education by which they become qualified for increasing management responsibilities.
- Shortage of highly trained e-business specialists. There is a huge demand to skilled and well-trained professionals who can design and build complete e-commerce solutions.
- Shortage of highly trained software engineers. The explosion of ICT industry has created more demand for software engineers. Egyptian universities could not produce enough graduates to meet that demand.
- Lack of interaction between the universities and IT industry. Universities in Egypt do not interact with IT industry in general. We believe that there should be stronger links between the universities and IT industry through joint graduate projects and grants.
- Inavailability of current IT and e-business textbooks and training materials. The ICT field is very dynamic and it is very hard to find current ICT books even at that the universities' libraries or the bookstores. Many interviewees mentioned that they have to order textbooks from Amazon.com and they can not afford to buy all the books they need.
- Non-existence of a Software Engineering Institute. There is no organization in Egypt that is in charge of setting standards to the software industry. Software contractors and multinational companies have no mechanism to judge the quality of the software they can expect from the software houses.
- Lack of local market demand to IT and e-business applications. The demand for IT applications needs to be stimulated by training managers in different industries on applying IT and e-business concepts at their organizations.

B. Opportunities and Possible Interventions

1. Technical Libraries

Libraries at the Egyptian universities and the bookstores do not have current ICT books or journals. The ICT field is very dynamic and ICT professionals have to keep up with the changes through continuing education and on-job training. The introductory course in programming languages has changed from Fortran to Pascal to C to C++ to Java in the last 10-15 years. These changes at the introductory level as

well as the advanced level have placed an extra burden on the professionals and employers working in the ICT industry.

It is very important to have technical libraries that can keep up with the changes in the ICT industry. Current libraries and bookstores have plenty of textbooks on Fortran and C but they do not have books on Java Beans. In addition, these libraries should have current journals and conference proceedings in the different fields in ICT. Finally, these libraries should have training courses on CDs from industry leaders such as Microsoft, Cisco, Oracle, Sun, Motorola, etc.

These libraries can be placed at the major universities that offer graduate degrees in ICT and the National Telecommunication Institute (NTI). Most of the above places have libraries but they need to be current and be able to respond to researchers and industry needs. Industry leaders in ICT might be interested in funding these libraries by donating their available training courses on CDs.

2. A Software Engineering Institute

There are many multinational IT companies that are trying to set software centers around the world. There is a huge shortage of highly trained software professional especially in the US. Many of these companies have established software centers in India, Ireland, and Israel. Although many of these multinational companies have sales offices in Egypt, none of these companies has established a software center in Egypt due to lack of qualified software engineers and the absence of a software engineering institute. **A Software Engineering Institute (SEI)** is a non-profit organization that certifies software companies and sets the standards for software development. It provides software contractors with a mechanism to judge the quality of the software they can expect from the software houses.

Software companies need to improve their own software productivity and quality by taking advantage of the collective learning in the field of software engineering, rather than trying to invent and develop these skills on their own. Fortunately, many of the lessons learned about the management of software development have been codified and made available to everyone to use. The Software Engineering Institute of Carnegie Mellon University in Pittsburgh, Pennsylvania has produced a widely accepted and used model called the Software Capability Maturity Model (SW-CMM). Thousands of software companies around the world have made use of its concepts to guide them in their efforts to improve their software engineering capabilities. The SW-CMM identifies 18 different Key Process Areas (KPAs), which represent general software management capabilities that have been shown historically to be successful development of software. They are organized into 5 different levels of "organization maturity" that captures the overall ability of an organization to successfully manage the development of software. These maturity levels provide guidance to an organization that wishes to improve its capability by suggesting a priority ordering organization skills to be mastered. There are many organizations that have achieved maturity level 2, but many fewer that have reached capabilities corresponding to

maturity levels 3,4, and 5. Many of these organizations have submitted significant amount of data to the SEI. This data provides a consistent view of the benefits that can result from consistently using the concepts and practices suggested in the SW-CMM model. Data analysis has clearly demonstrated that those organizations that have successfully improved their software engineering capabilities are far better able to utilize their resources and distinguish themselves from their competitors. Conversely, companies and organizations that are not engaged in improvement activities are falling further and further behind in their ability to distinguish themselves from their competitors.

We believe that establishing a SEI in Egypt will help software companies to produce better software in less time with higher productivity. The proposed SEI should have very strong ties with the SEI at Carnegie Mellon University because of its highly regarded international reputation. The private sector, USAID and universities in Egypt should become involved in establishing the SEI. It can be housed at one of the universities, or the National Telecommunications Institute (NTI).

3. Interdisciplinary Centers

The ICT discipline is very dynamic and young. Professionals who work in ICT industry need continuing education than any other discipline. There is a gap between the knowledge and skills needed in information and technology based workplace and the current level of preparation of the workforce. The ICT market in Egypt has severe shortage in the professionals who can manage big IT projects. Current university curriculums do not teach IT management skills, enterprise system analysis and integration, and ebusiness.

The interdisciplinary nature of the above areas suggest the need to establish interdisciplinary centers at some of the universities that offer graduate degrees/certificates in collaboration with the private sector. These centers can have faculty from the Schools of Engineering, Science, and Business. The American University in Cairo (AUC) has successfully established an Institute of Quality Management (IQM) that only focuses on management courses. The AUC has also established an Engineering Services unit to strengthen the relationship between the AUC and the engineering profession in Egypt and the Middle East. There is a huge demand to establish interdisciplinary centers that focus on the ICT topics related to the industry needs in Egypt and the Middle East. These centers should be equipped with distance learning capabilities and linked with major US universities industries

Short/regular courses that are intended for computer professionals and nonprofessionals seeking to enhance their knowledge in one or more areas of IT need to be organized. These courses should be taught by noted experts from industry and academia. In addition, some of these courses can be offered in collaboration with major US universities or industries through distance learning.

Courses/certificates need to be developed in the following areas:

- Software project planning and management.
- Legal essentials for protecting software development, acquisition, and use.
- The Engineer in Transition to Management
- High quality software engineering
- Software cost and schedule estimation

E-Commerce

- E-Marketing
- How to transform an existing business
- E-Branding on the Internet
- Internet marketing strategies
- Understanding E-Business
- E-Commerce for growing entrepreneurial business
- Internet security
- E-commerce: Technologies and Implementations

4. Grants/Scholarships

There is very low level of interaction between the IT industry and the universities. In addition, the IT industry complained about the lack of the practical experience of the recent graduates. The IT industry has to train new graduates for 6-9 months before they can be productive. We believe that this problem can be alleviated by establishing stronger ties between the universities and the private IT sector. Grants that are funded by the private sector and USAID can provide an effective tool that help establish the missing link between universities and the IT industry.

Some of these grants should fund graduate level projects in Software Engineering and related areas of IT. There are many students who are registered at the Masters and Ph.D. and never finish their degrees. According to one interviewee, the number of registered graduate students is more than 10 fold the number of students actually graduating. This means that there are many students who are willing to go to graduate school but they drop out due to financial reasons. We believe that establishing modest scholarships ($300/mo) will help retain graduate students and increase the number of graduates by at least 3 folds. In addition, the ICT industry can get graduate students to work in areas that they need.

We also believe that adding a practical training/internships requirement at the undergraduate level will help the ICT industry get the quality they need. Some students have started to work for ICT firms during summer to gain practical experience and the ICT companies are more satisfied with their level when they graduate.

2. Recommendations

A. Establish a Software Engineering Institute

It is very important to establish a Software Engineering Institute (SEI) whose mission is to provide leadership in advancing the state of the practice of software engineering to improve the quality of systems that depend on software. The proposed SEI in Egypt should have very strong ties with the SEI of Carnegie Mellon University (CMU) in USA. The SEI of CMU is a federally funded research and development center sponsored by the U.S. Department of Defense. The SEI contract was competitively awarded to CMU in December 1984. The SEI of CMU staff has extensive technical and managerial experience from government, industry, and academia.

USAID, private sector, and MCIT should jointly fund and establish a Software Engineering Institute in Egypt. USAID can fund 3-4 consultants from the SEI at CMU to visit Egypt for 5 weeks in order to establish an Egyptian SEI. The contract to establish the Egyptian SEI should be awarded to the best university entity on competitive basis. The Egyptian SEI should have very strong links with the very successful SEI at CMU in order to encourage multinational companies to start software centers in Egypt.

B. Establish Interdisciplinary/Excellence Centers

Interdisciplinary/Excellence centers that focus on the very dynamic ICT needs have to be established at different universities. These centers should have faculty from the Schools of Engineering, Science, and Business. The proposed interdisciplinary ICT centers should offer graduate degrees/certificates and short courses to professionals in ICT industry. These courses should be taught by noted experts from industry and academia. These centers should invite noted lecturers from the US to to give short courses that benefits the ICT industry. In addition, these centers should be equipped with distance learning capabilities in order to receive courses from major US universities and industries.

USAID, private sector, and MCIT should jointly fund these interdisciplinary/excellence ICT centers. Contracts should be awarded on competitive basis to universities.

Selection Criteria

- Clear demonstration of the successful coordination between the Schools of Engineering, Science, and Business in the proposed curriculum.
- Clear illustration of the center's interaction with ICT industry.
- Clear demonstration of mechanisms that allow the center to change the curriculum/certificates in order to meet the dynamic ICT demands.
- Partnership with US universities/industries that offer successful programs in IT.
- Clear illustration of mechanisms of getting feedback from the students and ICT employers in order to change the curriculum when needed.

C. Grants/Scholarships

USAID, private sector, and MCIT should jointly offer grants and scholarships to universities that focus on ICT topics. Awarding ICT grants to universities will help in establishing the missing link between the universities and the private sector. Priority should be given to projects that have private sector involvement. Awarding ICT scholarships will help retain graduate students in ICT and increase the number of qualified software engineers and IT managers.

The number of registered graduate students is more than 10 fold the number of students actually graduating according to one interviewee. We recommend the establishment of 200 scholarships/year to graduate students in the ICT area. Each scholarship should be ($300/mo) for 2 years. If students don't get their degree in 2 years, they should be required to pay back their scholarships and their universities should not be awarded future scholarships. Mechanisms to monitor the quality of these projects and their importance to the ICT industry should be established. The Egyptian SEI might help in that area.

We also recommend that USAID and MCIT provide matching grants to universities working on ICT projects that are funded by private sector. These grants will help to establish the missing link between the universities and ICT industry in Egypt. These grants can be used to help the universities upgrade their equipment, buy textbooks and journals, allow faculty and students to attend international conferences, and augment faculty salaries.

D. ICT Libraries

The field of ICT is very dynamic and the current libraries at the Egyptian universities and the bookstores do not have current ICT books or journals. All interviewees complained that they have to buy the books that they need through the Internet from the US or Europe. Graduate students cannot conduct their research because they do not have access to current journals and conference proceedings.

Regional ICT libraries have to be established. They can be placed at major universities that offer IT programs and the National Telecommunication Institute (NTI). We recommend that USAID and the MCIT participate in funding these libraries because there cannot be a meaningful IT industry in Egypt without these libraries. Private sector should participate in funding these libraries by providing technical courses on CDs. We recommend that USAID fund 5 regional ICT libraries at ($100,000/year) in order to help the ICT industry in Egypt. This money should be used in buying ICT textbooks and subscribing in ICT journals.