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Ghada Alaa

British University in Egypt, Ghada.Alaa@Bue.edu.eg

Dina Hussein

British University in Egypt, Dina.Hussein@Bue.edu.eg

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A ROADMAP FOR INTEGRATING WEB 2.0 TOOLS INTO IS TEACHING & REREARCH IN A DEVELOPING COUNTRY CONTEXT: THE EGYPTIAN PERSPECTIVE

Alaa, Ghada, British University in Egypt, Misr- Ismalia Desert Road, El Shorouk City,
11837 Helwan, Egypt, Ghada.Alaa@Bue.edu.eg

Hussein, Dina, British University in Egypt, Misr- Ismalia Desert Road, El Shorouk City,
11837 Helwan, Egypt, Dina.Hussein@Bue.edu.eg

Abstract

Web 2.0 covers technological advancements in peer-peer networks and Internet open architecture that facilitate better user interaction, participation and multimedia file sharing. This marks a new Web paradigm where the Internet becomes a huge social networking, collaborative forum. In this paper innovative Web 2.0 examples and enabling technologies are gathered to elaborate the significance of the new paradigm. Based on this analysis characteristics of Web 2.0 applications will be derived showing potential usage and benefits in teaching, learning and research. A case study, Faculty of Computers & Information, Cairo University, Egypt will be investigated in order to highlight limitations and/or prosperities of current IS education and research in a developing country context. It is argued that the digital divide gap represented in scarce technical infrastructure, skill shortage in specific areas like communication skills, business and management knowledge, as well as a bias towards heavy weight computer science areas, such as image processing and intelligent agents are hindering IS advancements in Egypt. Based on these findings the paper suggests how Web 2.0 tools can be integrated within current shortcomings and barriers showing a roadmap for Web 2.0 adoption in learning, teaching and research in a developing country context.

Keywords: *IS Research, Teaching, Web 2.0, Participation, Rich User Experience, Developing Country*

1 INTRODUCTION

The rapid evolution of Internet technologies and services over the past years have witnessed new tools such as blogs, wikis, social networking, bookmarking, and other related applications that offer rich user experience (Craig, 2007). For example, a blog is a system that allows a group of users to write and publicly display time-ordered posts/notes; whereas a wiki is a system that allows more than one author to co-create content using the Web page editing facility (Franklin et al., 2007). Beyond Web publishing, other activities have been involved in Web 2.0, for example photos and music sharing and editing, etc. The concept of "Web 2.0" began with a conference brainstorming session between Tim O'Reilly and MediaLive International; where O'Reilly referred to Web 2.0 as the "second generation" of Web-based services that emphasize online collaboration and participative computing among users (O'Reilly, 2005). Web 1.0 focused mainly on transactions; whereas Web 2.0 is more concerned with leveraging user participation and harnessing user-generated content (Cosh et al., 2008). Advancements in communication networks and distributed applications made it possible to deliver software as a continually-updated service. This goes beyond Web 1.0 published content to deliver rich user experiences; for example Office 2.0 is a Web application that provides sharing of online task lists, calendars, to do lists, reminders, planners etc., as well as allowing online file storage and sharing (Ganesh et al., 2007). Thus, Web 2.0 marks a new paradigm of Internet applications that focus more on user generated content, better interactions among users and providing rich user experience applications.

This paper investigates whether and how Web 2.0 tools may provide opportunities to reform our core practices of teaching, learning and research in the Mediterranean region. The area is still nascent and this paper provides an exploratory study of possible usage of such emerging tools. It highlights possible fruitful impacts on the learning and teaching experience in Mediterranean countries, as well as pin points gaps and constraints that would hinder adoption. This is achieved by firstly measuring the deficiencies and/or prosperities of current status of IS research and education in a developing country case study, Faculty of Computer & Information (FCI), Cairo University, Egypt. As compared to other informatics faculties in Egypt, FCI and generally speaking Cairo University are known of their flexible education style that would flourish creativity and enhance adoption of emerging technologies. Still several hinderments and constraints have been depicted through a thorough analysis of research and teaching activities of academic staff during the period 2000-2007. This will allow us to accurately measure any possible research, skills and infrastructure gaps and hence provide Web 2.0 adoption solutions that are feasible and best suit a developing country context.

2 WEB 2.0 TOOLS: CHARACTERISTICS, USAGE & BENEFITS

O'Reilly (2005) identifies eight major Web 2.0 types that include blog, wiki, podcast, mashup, web feed/RSS, social networking and social bookmarking. Several design concepts underlie the various Web 2.0 types as according to O'Reilly in an interview with Michael Baumann (2006) in Information Today magazine. He specifies the 'network effect' as a major cornerstone of Web 2.0 applications which implies the importance of modern communications networks and exploitation of the massive pool of networked users and their '*collective intelligence*'. He also points to '*information sharing*', '*user participation*', '*networked applications*' and '*knowledge*' as major characteristics of Web 2.0 applications. Ganesh & Padmanabhuni (2007) recur that Web 2.0 relies on leveraging the 'network effect' by attracting a large number of participants and enabling interactions between them. They conceptualise Web 2.0 as a mechanism to enhance a '*rich user experience*' by facilitating speedy '*collaborative participation*', '*content co-creation*', '*collaborative information exchange*', '*multimedia and file sharing*' and exploiting users' '*collective intelligence*' through tagging, rating and reviews. They also specify 'modularity' as a key concept for realising Web 2.0 applications. This implies the usage of small, modular technological constituents, for example availability of lightweight APIs (Application Programming Interfaces), RSS feeds and Web services have made *Mashup-based services* (for example Yahoo Pipes) easy to implement. Based on this discussion and by reflecting on different Web 2.0 applications discussed in various literatures as will follow, we can derive the following characteristics of Web 2.0 applications.

- **Participation:** The technologies related to Web 2.0 have created an architecture which encourages participation, where users can create and add to the content available on the Web. While in the past Webmasters were maintaining personal Websites, nowadays any user can create a blog, allowing visitors to actively participate through posting a comment (Cosh, 2008). Similarly, social networking sites collect data about members and then store them as user profiles. The data, or profiles, can then be shared among the members of the site allowing better interaction and participative engagements. Connecting people and leveraging interactions and participation among them are major goals of Web 2.0 (Barsky et al., 2006).
- **Content Co-creation:** This is another remarkable characteristic of Web 2.0 that allows for collaborative editing of same documents at the same time. This feature enables users to collaboratively work over the Web, either by editing content simultaneously or simply by sharing work edited by different individuals at different times (Franklin et al., 2007). Examples of tools that enable content co-creation include Office 2.0 applications, like Google Docs & Spreadsheets (for text), and Glimmer (for diagrams). Also

Wiki pages enable users to access an easy-to-use online editing tool to modify, add to or even erase shared content of the page. Hypertext-style linking between pages is then used to create a navigable set of pages of user-generated content.

- **Social Networking:** This refers to the service that allows people to network together for various purposes. Examples include Facebook and MySpace (for social networking or in other words socialising) and also LinkedIn (for professional networking) (Gajewski, 2008). Professional and social networking sites that facilitate people meeting, chatting and sharing content, lie mainly on exploiting the power of the crowd, or in other words the network effect (Anderson, 2007).
- **Content Tagging & Collective Intelligence:** Bookmarking becomes "user-oriented" when tagging is added to its functionality. Tagging means that the user can add a keyword (tag) to a chosen link in order to classify it. Other Internet users can search bookmarks through tags (keywords) to find content relevant to their interest. The process of organising information through "user-generated" tags has become known as 'folksonomy' (Owen et al., 2006). Introducing folksonomy has solved some problems of classification-based ontologies used mainly in search engine's intelligent agents. Traditionally content was classified through a taxonomy, which gathers related content together. Managing taxonomy is more difficult when the content is produced each second throughout the Web, in multiple languages and using various media types (Cosh et al., 2008). Folksonomy solves the problem by passing the responsibility of classification over to the user, this is referred to as collective intelligence. It is argued that searching within tagged content with users sharing the same interest will lead to more relevant results than relying on ontology-based search engines (Mathes, 2004; Gruber, 2007).
- **Content Aggregation:** While having continuously added and updated shared content it is important to keep up with changes regarding this content, especially when users are interested in multiple sources of information scattered on multiple Web sites. An aggregator or feed reader can be used to centralize all the recent changes in the sources of interest, and a user can easily visit the reader/aggregator to view recent additions and changes (Chowdhury et al., 2006). A feed aggregator is a Web application which aggregates syndicated Web content such as news headlines, blogs, etc. in a single location. The syndicated content which will be retrieved and interpreted by an aggregator is supplied in the form of RSS format (Sharp, 2006).
- **File Sharing & Podcasting:** Examples include YouTube (video) and Flickr (photographs). These popular services take the idea that users are not just consumers but contribute to the production of Web content. Thus Internet users participate in sharing and exchange of multi-media files, as well as producing their own. This development has only been made possible through the widespread adoption of high quality, but relatively low cost digital media technology such as digital cameras, apple i-pod technologies (that gave rise to podcasts, i.e. media files in mainly mp3 format that can be downloadable from the Internet and then run on i-pods), as well as advancements in peer-peer networks (Anderson, 2007).
- **Rich User Experience Applications:** Web 2.0 technologies allow for a more robust user experience than traditional Web applications. Rich user experiences are a combination of GUI -style (Graphical User Interface) applications and Multimedia content (Petrassi, 2008). It aims to build Web-based software that works and gives the user a similar experience like a desktop-based software program. A key technical component that facilitates this type of software is AJAX (Asynchronous Javascript and XML). According to Garrett (2005) instead of loading a Webpage at the start of the session, the browser

loads an AJAX engine that is responsible for both rendering the interface the user sees and communicating with the server on the user's behalf. The AJAX engine allows user's interaction to happen asynchronously, i.e. independent of communication with the server and in that way will speed up processing on the client side. AJAX technologies are applied heavily in applications, such as Gmail (Google's email program), Google Docs (online to-do lists, calendars, reminders and planners) and Flickr (a photo organizer and comment sharing application).

- **Mashup-based Services:** This refers to Web applications that combine data from more than one source into a single integrated tool this could be done by accessing open APIs and data sources to produce another application (Craig, 2007). So mashups are Web-based applications that intermix content from multiple online sources (McConchie, 2008). For example, Paul Rademacher's housingmaps.com combines Google Maps with Craigslist apartment rental and home purchase data to create an interactive housing search tool (O'Reilly, 2005).

Several literature assent that Web 2.0 concepts provide innovative tools and have started to influence business, education and research practice. They enable a rich-participative forum, better knowledge sharing and content co-creation, mashup-based services, and others. Several possible applications and benefits have been suggested in literature. For example, Kane & Fichman (2009) argue that Wikis enable better participation and content authoring facilities that would enhance research collaboration and publishing activities. Similarly Majchrzak et al. (2008) show a case of a so called exploratory learning during a conference paper presentation using a Wiki. Attendees collaborated by giving their feedback on the paper and shared their reactions simultaneously during the presentation which resulted in better learning and idea generation about the topic of the presentation. Whereas, Huang & Behara (2007) have explored their experience with Web 2.0 enabled MIS course delivery; such as MBA-level e-Commerce and Operations Management courses. They emphasize that the use of Web 2.0 have leveraged what they call "outcome-driven experiential learning". They mean by that a practice-based, interactive delivery, rich in social networking and mass authoring as opposed to the traditional delivery model limited in less participative instructional formats and sole dependence on classroom resources. Furthermore, Benlian & Hess (2007) stress the importance of Web 2.0 technologies in support of global software development activities. They argue that Web 2.0 tools, such as social networking, blogs, wikis, Web feeds and podcasts will facilitate collaborative generation of design ideas, enhance distributed pair programming, sharing of re-usable code, etc. In addition, Craig (2007) examines the impact of Web 2.0 tools on e-learning environments. As Web 2.0 environments facilitate a better collaborative platform; learners and educators will have it easier to share and edit content (e.g. lecture podcasts, publications, etc.), as well as form an interactive forum that would improve the learning and teaching experience. But this requires re-evaluation of vendor-specific e-learning systems as including Web 2.0 tools may find the architecture of such systems inflexible in contrast to the open architecture of Web 2.0 platforms.

3 CASE STUDY: FACULTY OF COMPUTER & INFORMATION (FCI), CAIRO UNIVERSITY, EGYPT

3.1 Background

Cairo University is the oldest and largest university in Egypt that serves more than 160 thousand students annually to meet the requirements of the Egyptian community and its development. Graduates of Cairo University have been evaluated and recognized at a global level, which has always been a source of attraction to foreign learners, especially those from Arabic-speaking nations. Within the framework of Cairo University the Faculty of Computers

and Information (FCI) aims to be effective in the applications of information technologies and systems to serve the Egyptian society. FCI achieves this through development of state-of-the-art curricula and research in the field of computers & information systems. The faculty has opened in the academic year 1996 – 1997. According to the faculty Website <http://www.fci-cu.edu.eg/>, the following information has been extracted regarding FCI various departments and specialities:

- Computer Science (CS): The department's mission is to produce scholars capable of creative work in computer science specialities. The program covers several areas of CS including programming skills and software engineering, artificial intelligence and soft computing, computer architecture and parallel processing and computer security.
- Information Systems (IS): Systems analysis & design are major activities for developing information systems; these cover systems of retrieving information (database systems), data searching, and data marts. In addition the department covers methodologies for information systems development, quality assurance of information system, economics of information systems, as well as applications of information systems in various fields, e.g. electronic commerce, bio-informatics, management information systems, geo-graphic information systems etc.
- Information Technology (IT): The department specialises in scientific domains related to information networks and multi-media, these include; communications technologies, e.g. the Internet, securing information and networks, processing digital signals, acquainting and generating speech, acquainting and processing pitchy photos, drawing systems of computer art and computer animated cartoon, multi media securing and compressing data, etc.
- Decision Support (DS): The department focuses on bases and concepts of Systems science, to include; foundations of operations, decision support methodologies, modelling and simulation, simulating computer languages, simulation of administration and economy, linear and non-linear programming, multi-goals programming, dynamic and random programming, systems of observing production and stock, systems of geographical information for decision support, games and crisis administration and others.

3.2 Methodological Approach

The main objective of this investigation is to explore what research areas are dominant in the Egyptian IS Community. We will then reflect on top international IS research areas and emerging Web 2.0 practices in order to find out prosperities and/or deficiencies in IS education and research in Egypt. This will result in identifying how far the research community is from adopting Web 2.0 tools and emerging IS concepts. Based on this analysis we will derive skills and IS practices required to improve IS research and education in a Mediterranean context in Web 2.0 era. The investigation is based on one in-depth case study in order to analyse research activities and areas of specialties of the faculty staff. While it is difficult to generalise from one case, it is important to note that FCI is one of the largest computer science and informatics faculties in Egypt. Other universities in Egypt, such as Ain Shams and Helwan have also remarkable contributions in the area of computer science and informatics, but their research status will be more or less similar to FCI. Moreover Ain Shams is well known of targeting heavy-weight specialities, such as simulations and image processing, whereas FCI and Helwan adopt a light weight approach.

In order to tackle the status of IS research at FCI Ph.D. & M.Sc. registrations during the years 2000 and 2007 have been surveyed. Source of data are the records of the Administration of Postgraduate Studies at FCI. A publication including these records have been even disseminated along with the proceeding CD of the 6th FCI annual conference, INFOS 2008, that

took place from 27th to 29th March, 2008 in Cairo, Egypt. It is found that total of 392 M.Sc. & Ph.D. registrations have been registered during this period, of which 25 Ph.D. degrees and 105 M.Sc. degrees have been awarded. The research method covered mapping the registrations to the various research topics of the four departments; CS, IS, IT & DS as specified in previous section. It is found that some registrations could be relevant to more than one research topic. In order to ensure accuracy of results these registrations have been revisited with a senior FCI staff member, Head of IS Department, to specify to which research area the contribution of the registration belongs to. Then a statistics have been produced to specify the occurrences of each research topic.

Other methods included observations, as one of the authors taught the course “Fundamentals of Information Systems” to students of level 3 from the four departments, during the winter semester (2007-2008) & summer semester 2008. These observations covered mainly the Web 2.0 invented activities by students who unintentionally were seeking a way to overcome limitations due to lack of a collaborative e-learning system at FCI.

4 FINDINGS

The concern of many staff is narrowly focused on technical aspects, which is reflected in M.Sc. and Ph.D. topic areas registered at FCI. Figure 1 (see Appendix) shows the percentage of postgraduate studies registered at the IS department as compared to the other three departments within the period of 2000 and 2007. It is noticeable that the number of research projects in CS, IT & DS (total of 320 projects/ 82%) heavily overweighs IS research (total of 72 projects/ 18%).

In the following we will investigate the number of M.Sc. & Ph.D. registrations in various research areas at the four departments. To make the information easier to assimilate, we collate CS, IT & DS departments’ research themes together (Figure 2 for Ph.D. projects & Figure 3 for M.Sc. projects, see Appendix). We also organize the research themes in information systems (IS) into three main categories:

- IS Technical Building:
 - Database (DB)
 - Datawarehousing (DW)
 - Data Mining (DM)
 - Web DB & Web searching
 - Web technologies
 - XML
 - Arabization
 - Security
- IS Development and Applications:
 - HCI
 - SW architecture
 - ISD methodologies
 - e-Commerce
 - e-Learning
 - e-Government

- Biomedical informatics
- GIS
- IS Management & Context:
 - IS auditing
 - IS quality
 - Project management
 - Risk management

Based on this analysis it is found that CS, IT & DS research is more established with a variety of specialized areas, such as image processing, computer networks, security, artificial intelligence, soft computing, simulations & others. Top Ph.D. areas in CS, IT & DS are Modelling & Simulation, Artificial Intelligence and Decision Support Systems. Top M.Sc. areas in CS, IT & DS are Decision Support Systems, Computer Networks, Security and Image Processing. On the other hand IS research is still under-developed relative to the other more technically-oriented research aspects of computer based systems. Top research areas in IS (M.Sc. & Ph.D. combined) are Web Database, Web Technologies, IS Methodologies, GIS, Data warehousing & Data mining. But Bioinformatics research is considerably low at FCI as compared to GIS research (6 times less). FCI needs to focus more on bioinformatics research taking into consideration its significance to societal development. HCI, Arabization of IS applications & IT Project Management are important IS research areas but with little contribution at FCI. Based on this analysis (Figure 4, 5 & 6, see Appendix) the following IS research theme ranking at FCI during the period 2000-2007 can be derived (Table 1).

1	Web Database & Search
1	Web Technologies
1	ISD Methodologies
4	GIS
5	Data Warehousing
6	Data Mining
6	XML
6	Software Architecture
6	IT Project Management
10	IS Quality
10	Security
10	HCI
13	e-Commerce
13	e-Learning
13	e-Government
13	IS Auditing
13	Database Systems
18	Bio Informatics
18	Risk Management
18	Arabization

Table 1: Ranking of IS Research Themes at FCI 2000-2007

International IS research has other perspectives as implied by Sidorova et al. (2007). They gathered abstracts from research articles published in seven leading MIS journals during the period of 1985-2006 and in each of the 5-year windows (1987-1991, 1992-1996, 1997-2001 and 2002-2006). Journals under investigation included MIS Quarterly (MISQ), Information

Systems Research (ISR), Journal of Management Information Systems (JMIS), Communications of ACM (CACM), Management Science (MS), Information & Management (I&M) and Decision Sciences (DS). By applying text mining techniques on gathered paper abstracts latent semantic factors were extracted that characterize key IS research themes in the papers. Ranking of identified themes was then based on the publication count within the period under study. This analysis highlighted top IS disciplines for Web 1.0 paradigm during the period 2002-2006, these include:

- Top Web 1.0 IS International Research Topics (Adopted from Sidorova et al., 2007)
- Online consumer behaviour
- Electronic marketplaces
- Website design
- Trust in IT enabled services
- Virtual teams
- IT Measurement Instruments
- Economics of IT
- IT Value Creation
- Knowledge Management Systems
- Customer Service
- IT Adoption and Technology Acceptance

By comparing Table 1 with international IS research topics it becomes apparent that IS research at FCI focuses more on technical aspects of IS. This is reflected in Web technologies and Web database & search as top IS themes at FCI as compared to electronic consumer behaviour and electronic marketplaces on international level. Then comes ISD methodologies as second important IS theme at FCI. Data warehousing, data mining, XML, as well as SW architecture attracted more attention at FCI than on international level. IS management themes like IT adoption, economics of IT, the value of IT & technology acceptance that are of importance to IS research internationally did not appear in FCI research. IS applications like GIS & Bioinformatics attracted rather more attention at FCI than on international level. HCI, organizational behaviour and IS management topics need to be further developed at FCI as currently they have poor representation. Problems occur in such areas due to dismiss of staff candidates who earned their doctorates in, for example the effect of culture on user interface design for e-commerce systems, as belonging more to Arts or Commerce faculties, rather than Information Systems. Still the IS research culture in developing countries is more directed to quantitative aspects whereas qualitative research in this area is undermined.

With regard to Web 2.0 technologies and techniques, there were no registrations tackling these concepts. Major reason is that staff research is more directed to semantic Web and mobile intelligent agents and search engines (Web 3.0) than to social networking and collective intelligence function of the Web. It seems that the wording of Web 3.0 that refers to the intelligent aspect of Web applications gives the impression that Web 2.0 concepts are outdated, although both areas are integral and are still emerging.

But, the first author witnessed an interesting phenomenon of unintended use of Web 2.0 concepts by students at FCI. During the delivery of the module "Fundamentals of Information Systems" to year 3, the author was handed at the end of her first lecture a piece of paper indicating the newsgroup year 3 students had created on Yahoo. They asked her to join the group and disseminate her PowerPoint presentations on the newsgroup. This worked fine at

the beginning but when the presentations' size became heavy one of the students came up with the idea to post the presentations on a file sharing site instead. The author also witnessed multiple discussions between students through the news group, these tackled important announcements regarding grades, change of schedules, collaborations on assignments, etc. It is important to mention that FCI did not provide an e-learning suite; just an online system of grade dissemination was in its first stage. Because of this gap students created their own Web 2.0 forum as a substitute, which implies the significance of such concepts to IS education & research. According to Turban et al. (2008) the use of Web 2.0 tools in IS applications in general and in e-business in particular will form a substantial portion of the economy in the coming years. Therefore these tools and techniques need to be apart of IS research and education where contributions need to target a rigorous approach investigating such technologies through conceptual frameworks and models.

5 IS RESEARCH & CURRICULA REQUIREMENTS FOR EGYPT IN WEB 2.0 ERA

Egypt is witnessing an educational reform where a new Egyptian Education Initiative (EEI) was signed in November 2006. EEI emphasizes collaborative Public Private Partnerships (PPP) as a key model to sustain educational development. The Ministry of Education (MoE), Ministry of Higher Education (MoHE) and the Ministry of Communication and Information Technology (MCIT) have, with the support of the World Economic Forum, multinationals and donors, put in place several pilot projects to improve the educational system and provide ICT to all Egyptian universities and schools at an affordable cost.

In particular, EEI pin points skills shortage in several key areas in which training is required, these include:

- English language
- Soft skills
- Entrepreneurship
- Project management
- Consulting & Solutions skills development
- Business concepts
- Marketing fundamentals
- e-Learning content development & standards
- Instructional design

Design of curricula in the above mentioned subjects is paramount for developing countries in order to overcome skill shortage in teaching and learning. It is argued that these curricula requirements and technological advancements would drive the reform as they put forth necessary knowledge and skills required to improve IS research in developing countries. Without these skills no significant progress will be witnessed in IS research areas like human computer interaction, consumer behaviour, IT adoption, virtual communities, economics of IT, etc.

With respect to Web 2.0 applications, Ganesh & Padmanabhuni (2007) emphasise that the interplay of emerging Web 2.0 technologies with the standards of Service- Oriented Architecture (SOA) that facilitate the development of distributed and interoperable applications will form the foundation of future IS developments. In order to have insight into emerging IS topics for Web 2.0 environments call for papers of well-known IS conferences and journals (e.g. AMCIS2009, AIM2009, Journal of Information Systems Education-JISE,

International Journal of Information Systems in the Service Sector-IJISSS) during the years of 2008 and 2009 have been surveyed.

The following emerging IS research topics for Web 2.0 can be derived:

- Theorising Network Effect
 - Analysis of social networking patterns and trends
 - Strategic impact of social networks (e.g. as a marketing and/or advertising tool)
 - Frameworks and models of social networking systems
 - Distributed design & development networks
 - Web 2.0 usage within Global Software Development
 - Web 2.0 development methodologies
- Business Value of Web 2.0
 - Web 2.0-enabled business models
 - Web 2.0-enabled value creation
 - Web 2.0-enabled organisational strategies
 - Web 2.0 adoption models
- Applications of Web 2.0
 - Enterprise 2.0
 - e-Learning 2.0
 - Web 2.0 & e-Commerce
- Web 2.0-supported Technologies & Techniques
 - Web services
 - Peer-Peer Networks
 - Mashup-based services
 - Rich user experience applications
 - Folksonomy
 - AJAX, XML, RSS, etc.
 - Information Quality

In order to measure limitations and/or prosperities for integrating Web 2.0 concepts within IS research and teaching we reflect on current status of IS research at FCI (see previous section). It becomes apparent that the IS community in Egypt needs to pay more attention to emerging IS disciplines, like Web 2.0 concepts and Service-Oriented Architecture (SOA), rather than just focusing on Web 1.0 development tools and techniques, such as XML, Web database and search. Web 2.0 tools can be specifically integrated within research areas, like e-commerce, e-learning, e-government, e-health and GIS applications.

We conclude that EEI is a good start to put forth the technical infrastructure for e-learning and computer-equipped class rooms, as well as leveraging soft skills, business and management knowledge in a developing country context. But this is not enough as universities need also to exploit benefits of Web 2.0 tools, such as participation, networking, file sharing, podcasting, etc in learning, teaching and research as has been discussed in section 2. Hence beside EEI

curricula and infrastructure reform the following activities will become necessary to fully harness IS research and education in Web 2.0 era:

- Emphasis on Multimedia technologies
- Web 2.0-based delivery of IS courses; e.g. e-commerce, MIS, etc.
- Web 2.0-based e-learning facilities, e.g. podcasting of lectures, file sharing, social networking, etc., as well as emphasis on SOA architecture for e-learning systems
- Web 2.0-enabled distributed design & development networks, using e.g. wikis, social networking, mashup-based services
- Emphasis on prominent Web 2.0 research areas, e.g. mashup-based services, SOA architecture, P2P networks, rich user experience Web applications, folksonomy, modelling social networking systems and Web 2.0 enabled Global Software Development (GSD)

It is suggested that these undertakings provide innovative tools and models for professional development in modern environments. These would leverage IT readiness and global competitiveness of developing countries in Web 2.0 paradigm. Findings of practical applications of such concepts will be considered in subsequent publications, as the authors are currently engaged with a Web 2.0- supported delivery of an undergraduate e-commerce course, as well as aiming to implement Web 2.0 tools within e-learning activities at their university portal.

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APPENDIX

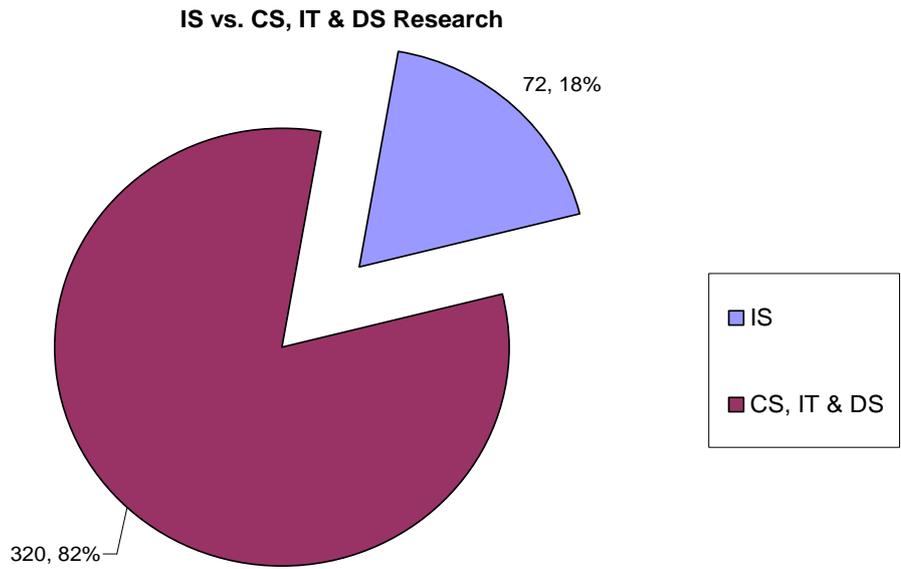


Figure 1: IS versus CS, IT & DS Research (Percentage of Projects-MSc & PhD) 2000-2007

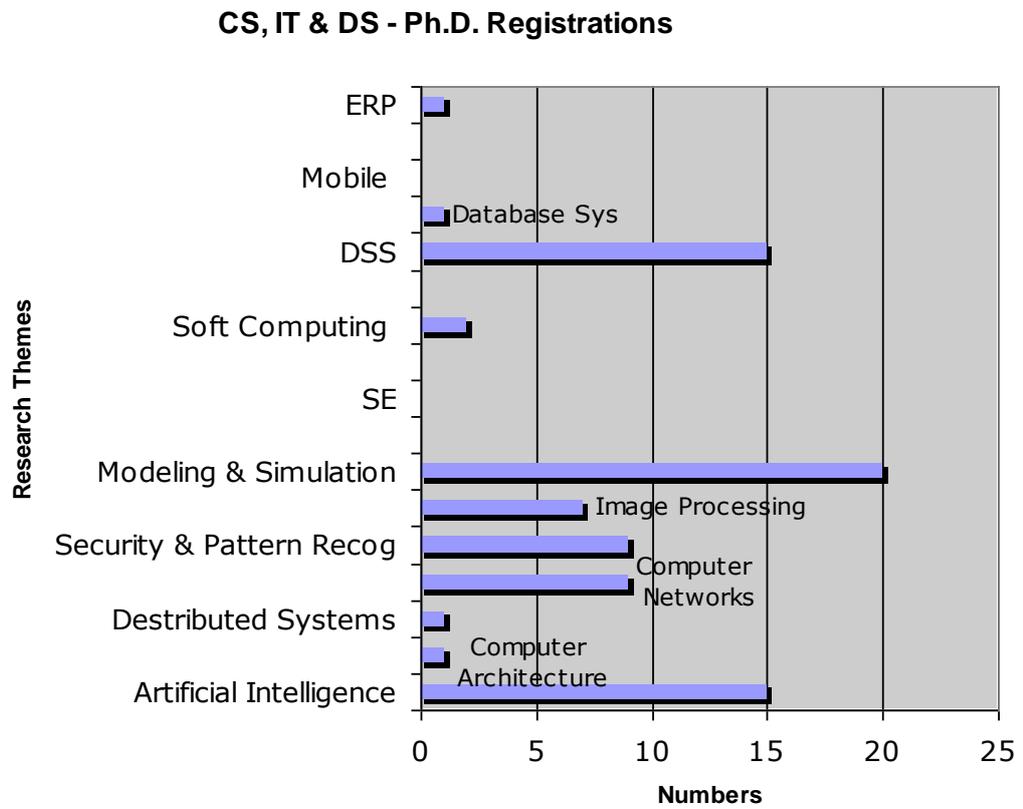


Figure 2: CS, IT & DS Ph.D. Registrations 2000-2007

CS, IT & DS - M.Sc. Registrations

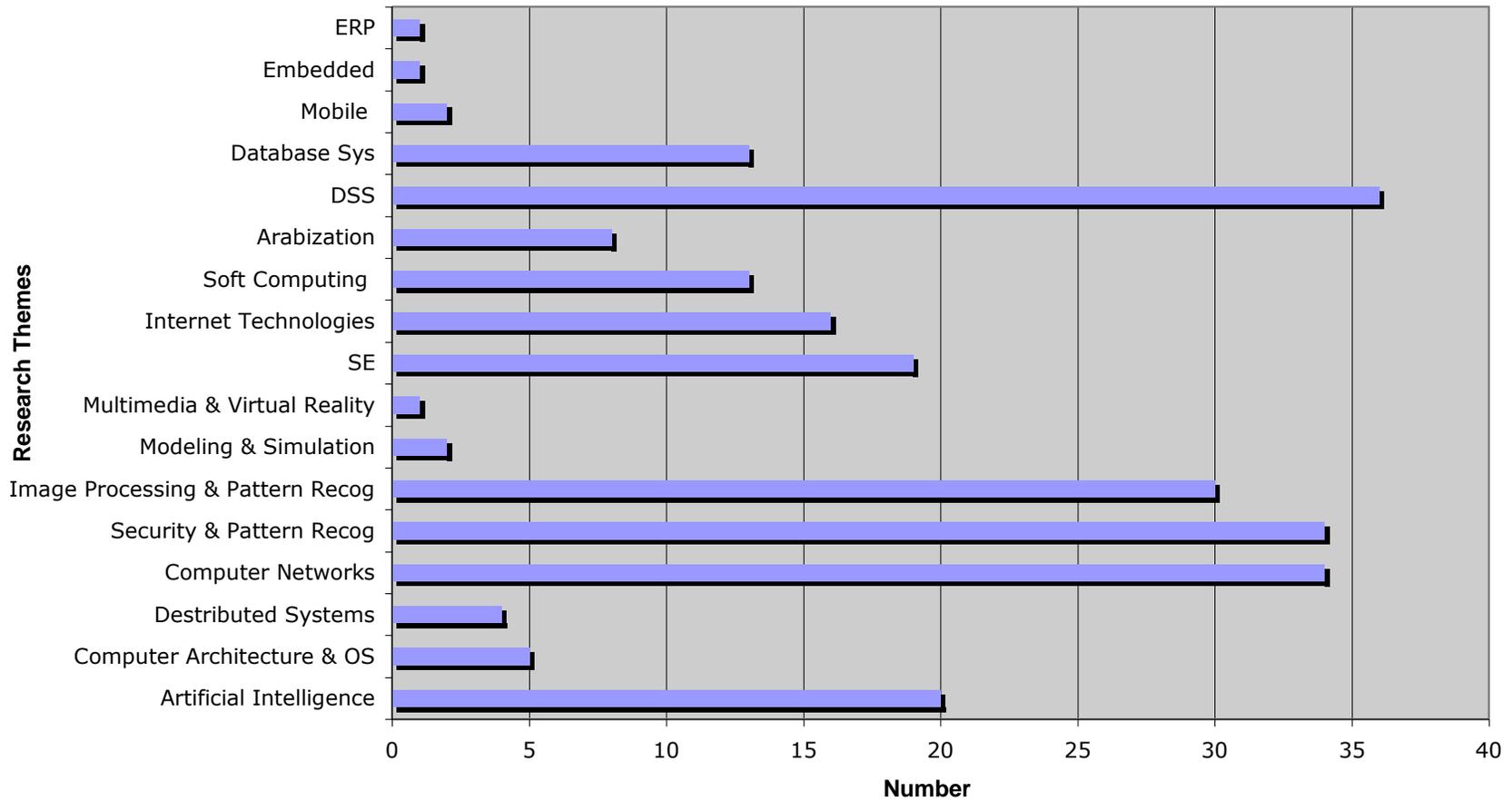
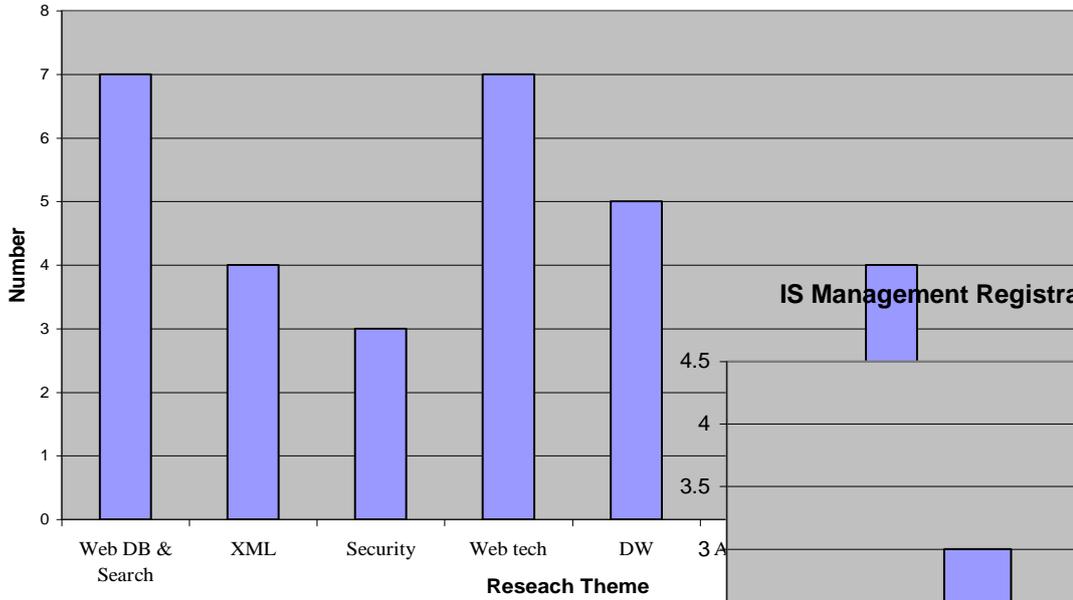


Figure 3: CS, IT & DS M.Sc. Registrations 2000-2007

IS Technical Building Registrations (M.Sc. & Ph.D.)



IS Management Registrations (M.Sc. & Ph.D.)

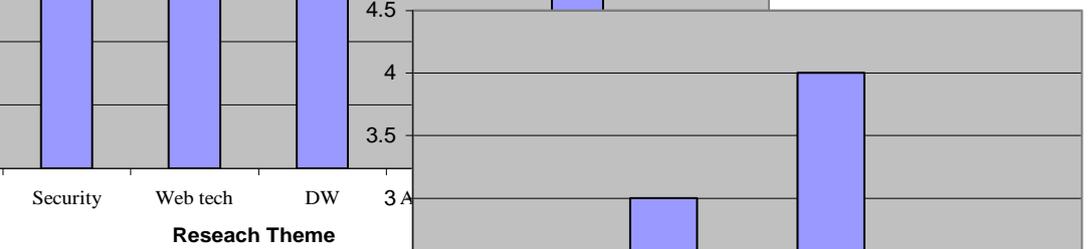


Figure 4: IS Technical Building Registrations (M.Sc. & Ph.D.) 2000-2007

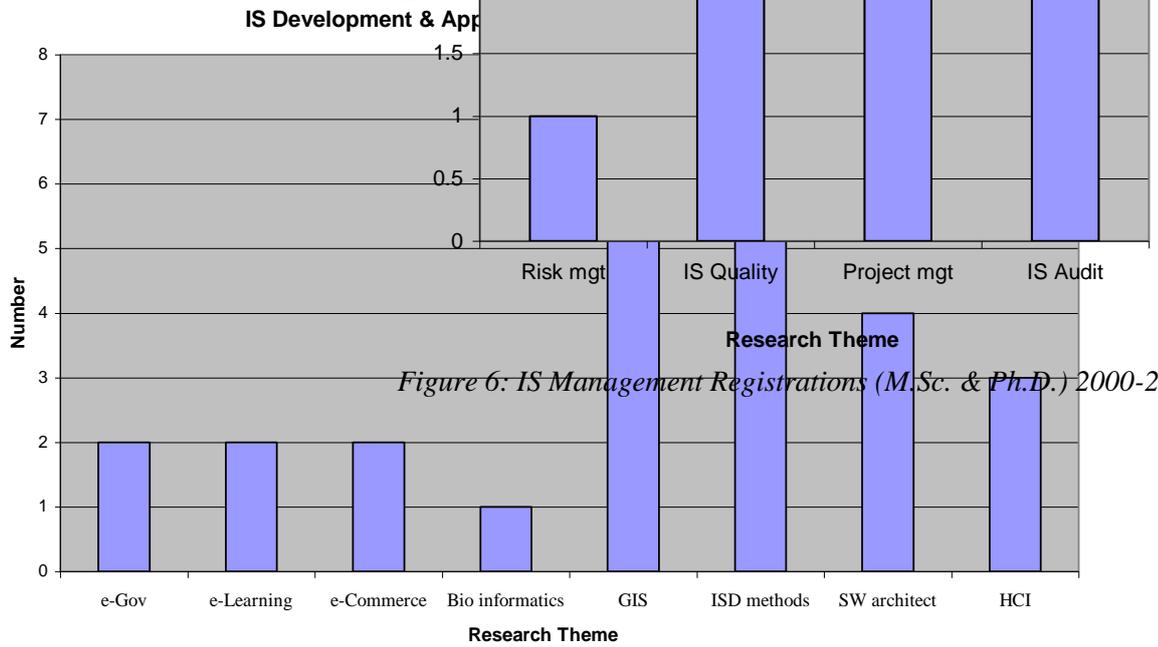


Figure 5: IS Development & Applications Registrations (M.Sc. & Ph.D.) 2000-2007

Figure 6: IS Management Registrations (M.Sc. & Ph.D.) 2000-2007