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The electronic college: A study of the effectiveness of electronic management systems within colleges

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ABSTRACT

Electronic Management Systems (EMS) today play an important role in organizations as they simplify managerial tasks, improve resource utilization and improve efficiency. King Abdul-Aziz University is a leader in the use of technology among Saudi universities. Its focus, like several other universities, has been on building centralized EMSs which tie different departments across campus using a centralized network. The systems, however, do not aim to automate managerial tasks within the colleges themselves. As the amount of managerial work within colleges is huge and redundant, this research aimed to evaluate the effect of automating college's internal affairs on performance. An EMS (EAASy) was built for the Academic Affairs department of the Women's College of Computing & Information Technology and was used as a test-bed to evaluate the effectiveness of an EMS within the College. Both manual & electronic systems were used for an entire semester for comparisons. Quantitative and qualitative measurements were used. Statistically significant differences between the two systems were found. This paper includes an overview of the research methodology used in this project. It also includes results, implications, and recommendations established by the researcher.

Keywords: electronic management systems, information system, e-college, electronic college, academic affairs, distributed system, centralized system, hybrid system

INTRODUCTION

Electronic Management Systems (EMS) gained huge popularity in recent years due to the important role they play in simplifying managerial tasks and improving performance efficiency. Benefits of EMS include human error reduction, reduction in time required for task completion, and easier information retrieval, to name a few.

King Abdul Aziz University (KAU) is a leader in the use of technology among Saudi universities. Its IT focus has been on building centralized systems, such as the HR System and the Electronic Communication System, which tie different departments across campus using the University's centralized database and network. Centralized systems are systems in which system resources, such as software, hardware and data, all reside on a central single server. KAU current efforts do not aim to automate managerial tasks within the different colleges; rather, the current focus is to improve overall usage of technology across campus and to enhance data sharing and communication from one end to another, as it has a larger impact on the University as a whole.

As the amount of managerial work within colleges is huge and redundant across colleges, this research was aimed to evaluate the effectiveness of automating such managerial tasks within colleges. These tasks include tasks in academic affairs, daily managerial tasks, internal communication, and other redundant tasks.

The research proposed the usage of a distributed database management system for college-specific applications. Distributed

architectures are usually used when system resources, such as applications and data, do not need to reside on a central server. Instead, system resources are distributed on multiple servers at the sites they serve. Using such architecture enables the colleges to have their own copies of their data and their applications on their servers. The processing of applications on the college distributed servers enable improved availability, less bandwidth requirements and better fault-tolerance than when a centralized approach is used.

This research does not propose universities move away from fully centralized architecture, as the one found at KAU, to completely distributed system. Rather, the research proposes using a hybrid architecture, which is a mixture of a centralized and a distributed system (Von Simson 1995). By using a hybrid architecture, it is hoped that benefits of each will be maximized and drawbacks of each minimized.

Literature review

The next sections compare and contrast centralized to non centralized EMS. Distributed systems are also defined. And, a discussion of research found that is related to EMS in academic settings is presented.

Centralized & Non-Centralized systems

In centralized electronic systems, system resources, such as hardware, software, data and applications, reside on a central server. All queries sent out by users of the centralized system pass through the central server where they are processed. In a decentralized electronic system, system resources reside on each of the client machines that are connected through a network. Network centralization is characterized by six principal advantages: easier-to-enforce uniform standards, easier workstation support, repair, and maintenance, easier software installation, upgrades, and patches, lower support costs, improved service to end users, and economies of scale for hardware. A decentralized scheme is characterized by three principal advantages: minimal bandwidth requirement, less-restrictive software design requirements, and more end-user choice regarding workstation configuration (Schuff & St. Louis 2001). The best solution for a specific IT department depends on several factors, including bandwidth availability, application modularity, and the uniformity of an organization's workstation configurations. In a survey conducted in 2002, 61% of organizations were centralized (CIO Magazine 2002). Major companies in the US report up to a 50% reduction in the total cost of ownership as a result of centralization and standardization in a thin-client environment (Schuff & St. Louis 2001; Wheatley 1998; Anthes 1998).

When information technology was first introduced to organizations in the 1960s, it was usually centralized. Cost was the determining factor. The need to improve responsiveness and flexibility, coupled with technological advances, by the mid 1970s, enabled decentralization. By the mid-1980s, software became accessible to nonprogrammers who were expected to be able to run simple applications. Servers also became widely available. As a direct result, the IT function began to be decentralized, with departments managing their own IT hardware and software. This trend generated a large amount of different and not-easily connected hardware and nonintegrated software applications. This was a next call in 1987 to go back to centralization (LaBelle & Nyce 1987). And by 1992, a new shift toward decentralization started through renewed perception of increased service quality provided by decentralization and by an early push toward Web solutions. Large organizations (such as Siemens and General Motors) began using e-commerce and B2C companies (such as Amazon.com) were dispersing their servers worldwide to improve response time. By the late 1990s, another shift towards re-centralization occurred promoted by several motivations, such as cost (Evaristo, Desouza & Hollister, 2005).

IT departments continue to struggle, over whether to centralize or decentralize applications ((Schuff & St. Louis 2001). Colleges, like other organizations, followed the same IT path (Brown 2002).

Distributed systems

A distributed system consists of a collection of sites that are connected together by a network. Each of these sites is a full system site in its own right. However, a user at any site can access

data anywhere in the network in a transparent manner (Date 2000). Furthermore, the distributed system database may be stored in multiple computers located in the same physical location, or may be dispersed over a network of computers (Wikipedia 2007). Distributed systems have been claimed to be inherently more reliable than centralized systems, because the propagation of low-level hardware and software errors is restricted by physical separation of processes and resources. Queries initiated at sites where the data are stored can be processed locally without incurring communication delays, and the workload of queries can be distributed to several sites (Son 1988). Distributed database schemes have other advantages such as scalability and local autonomy of data and modularity, where systems can be added or removed without affecting the other modules. Disadvantages of distributed systems include the complexity of the overall system, extra labor cost needed for updates & maintenance, security problems, and the difficulty in keeping the integrity of the overall data. Distributed systems are drastically more fault tolerant and more powerful than many combinations of stand-alone computer systems. They are also continually open to interaction with other systems.

Replication & redundancy

Replication refers to the use of redundant resources, such as software, hardware, data or application components, to improve reliability, fault-tolerance, or performance (Joseph & Birman 1986; Son 1988; Ruan & Tichy 1987). Replication typically involves replication in space, in which the same data is stored on multiple file systems or the same computing task is executed on multiple devices, or replication in time, in which a computing task is executed repeatedly on a single device. (Narasimhan 2002; Son 1988). In this research we propose the use of replication in space.

University & college IT setup

On some university campuses, needs for IT and IT support vary from college to college and from school to school. The needs differ depending on the number of students, number of faculty members, available labs, and facilities (Borkowski, Elvove, Higgins & Kueppers, 2004). Although it is hard to generalize one-size-fits-all IT solutions to the different schools on a campus, many of the schools' basic functions, such as course scheduling, are all performed in very similar ways. Centralizing some of the maintenance and user support services has proven to reduce cost and improve quality for colleges. Nonetheless, centralizing application server support has been proven less effective (Borkowski, Elvove, Higgins & Kueppers, 2004).

In 1990, Claremont University first put forward the concept of "Campus Computing". Followed are several universities around the world (Hongxin, Gang, Ming & Lili 2006) . Beijing University and Hong Kong University launched the first international research of higher education informatization ACCS (Asian Campus Computing Survey) in Asia, which started the E-Campus of universities and colleges in China (Guodong, 2003) . As a result, universities and colleges worked on building different applications, resulting in digital libraries, online teaching, electronic teaching plans, electronic homework, and paperless operations. Building digital intelligent office environments became the most important part of the E-Campus system (The Ministry of Education of the People's Republic of China 2007) .

Owens & Sheldon (1999) describe an automated Academic Affairs Information System (AAIS) that was built at the Webster University to allow efficient exchange of information between main campus and its 70 remote sites in the U.S., Europe, and Asia as an example of a successful distributed database application. The approach provided good scalability and availability. Before the system, the sites used to mail or fax information to the main campus, where it was manually entered into the main campus computer (Owens & Sheldon 1999).

Research objective

As the amount of managerial work within KAU colleges is huge and redundant across different colleges, this research aimed to study the effectiveness of automating such managerial tasks within colleges. The research evaluated the effectiveness of the use of an electronic distributed database management system for college-specific applications, as measured by time spent on a task, number of errors committed while performing a task, and system ease-of-use.

MATERIAL AND METHODS

In order to achieve the project objectives, seven major steps were performed. The project duration was ten months.

First, a detailed action plan was prepared. Participants were chosen and awareness about the project was spread across the college. Second, College administrators documented all tasks they perform on daily basis and the steps in each task. Each task was filled as a procedure in a separate form using standardized templates that were developed in accordance with ISO 9001 standards. Each department later produced a Procedural Handbook that contained all procedures and forms. Third, tasks that could be automated from the fundamental task list were specified, either because they are repeated constantly, they require large human efforts, such as course load evaluation and annual budgets, or because they are complex tasks that require the use of several resources for decision making, such as exam scheduling. Fourth, the Electronic Academic Affairs System (EAASy) was built using a traditional seven step System Development Life Cycle (SDLC). Fifth, an experiment was carried out in which EAASy was used to evaluate the effectiveness of an EMS within colleges. Sixth, the collected data was analyzed to evaluate whether using an EMS within colleges improves performance. Finally, recommendations were produced.

The following sections give an overview of EAASy, the experiment, and the results from the experiment.

The electronic academic affairs system (EAASy)

EAASy was developed using PhP, Cascading Style Sheets, JavaScript, HTML, MySQL and a MySQL server. The system has three main users: Employee, Student, and Supervisor. The design of the GUI was adapted from the CCIT website, with a few changes. A log in screen was also added to the system. Usability of The GUI was tested and was approved by the Academic Affairs Staff. The main tasks offered are related to: Student Specialization, Internal Communication, College Subject Schedules, Exams, and Daily Activities (Performance Reporting).

Following is a brief description of each of the main tasks.

Process 1. Major specialization system

The system enables the Academic Affairs staff to distribute new college students in the three different departments: Computer Science, Information Systems, and Information Technology, depending on their GPAs, requests, and department capacity. If department capacity limit is reached, the student will be assigned to her second choice department, if available seats exist. Otherwise, she will be assigned to her third choice.

Process 2. Internal communication system

The Internal Communication system enables the user to Save & View both incoming & outgoing mail.

Process 3. Final exam schedule system

EAASy enables users to build the Final Exam with ease and speed. First, the user specifies the dates of the exam period. Next, she enters the Final Exam schedule key provided by the University. And finally, she enters the General College Subjects and their times. The System then produces the entire Final Exam Schedule that includes both General and Specialty Departmental Subjects. Users can also Edit Exam Dates, Assign Rooms to Exams, and Distribute Exams to Observers.

Process 4. Activities (Performance Reports)

Academic Affairs employees enter their tasks and update the status of tasks through the EAASy System. Thus, they can organize their work and plan their days effectively. Furthermore, the Head of the Department can review employee status reports and be informed about their completed tasks, current tasks and future plans.

Process 5. Subjects schedule

EAASy also enables the electronic production of the Subjects Schedules for the entire College. Users can also Display the Schedule, Print the Final Version, Assign Rooms to Sections, and Search for Information.

The Schedule is only populated once to the System's database, when the System is used for the first time. The populated Schedule will

become the Default Schedule for future use. This was requested by the Academic Affairs Administration, as normally the departments offer the exact same schedule most semesters, with very few changes.

The experiment

Once the Academic Affairs system was completed and tested for usability, an experiment was carried out at the Women's CCIT to evaluate the effectiveness of the use of an electronic management system within colleges. Both manual & electronic systems were used for an entire semester to make the comparisons. Quantitative measurements, such as Number of Errors, Time needed to complete a task, and the Ease of Use were all collected. Qualitative data was collected during the usability testing of the system. Academic Affairs employees from the different units were all asked to evaluate all major processes in the system using a collection questionnaire. They were asked to list all advantages and disadvantages of the system.

Data collection

In order to collect data, a member of the Research Team filled an evaluation form for each task. The form, contained fields to record the time needed and the number of errors conducted while performing the task through her own observations. The ease of use for each task was recorded as reported by the staff member responsible for performing that task. The rating of the ease of use was recorded based on her direct interview-like question addressed to the responsible staff member after performing the task. The opinions were captured using a likert scale with "1" representing an "Easy-to-use" rating and "3" representing a "Difficult-to-use" rating.

Once all data was collected for major processes, Academic Affairs staff members were given a comparison sheet to compare the EAASy system to the manual system, through identifying the advantages and disadvantages of each one based on a given task. A separate comparison sheet was created for each task and was filled out by only staff members who are responsible for these tasks in their daily work and those who have a role in it.

RESULTS

Table 1 list the mean Numbers of Errors conducted, Time needed, and the opinions of people about the Ease of Use of the system (EAASy vs. Manual System).

In the Number of Errors, the mean Number of Errors (μ_{errors}) in the Manual System (2.36) was much higher than those resulting when using the

Table 1: Comparing the manual system to the E-System

System		Ease	Time	Errors
E-system	Mean (μ)	1.00	101.91	.18
	N	11	11	11
	Std. Derivation	.00	231.084	.408
Manual System	Mean (μ)	2.18	985.09	2.36
	N	11	11	11
	Std. Derivation	.603	1592.318	2.942

E-System (0.18). Figure 1 shows the comparison. In the Time spent on a task, the mean Time (μ_{time}) spent in the Manual System (985 minutes) was much higher than Time spent when using the E-System (101.91 minutes). Figure 2 shows the comparison.

In the Ease of Use, users rated the Manual System (μ_{ease}) as (2.18) compared to (1.0) on their

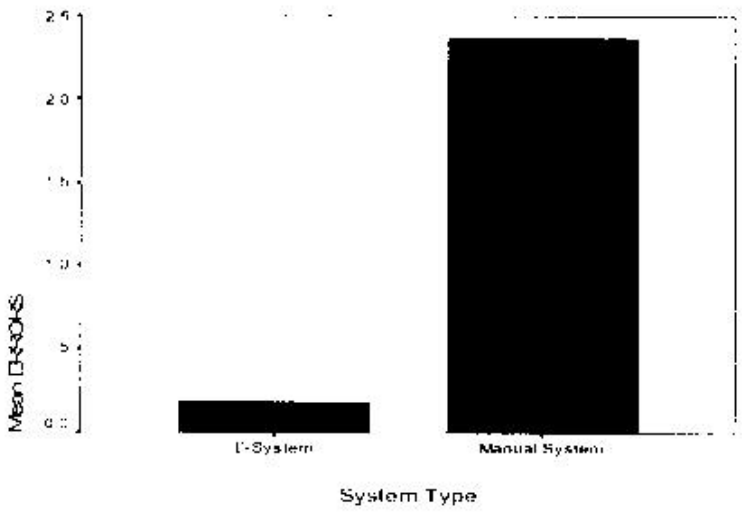

Fig. 1: Comparing number of errors based on system type

Table 2: Statistical analysis of data

		Levene's Test for quality of variance		t-test for Equality of means						
									95% confidence interval of the differnce	
		F	Sig	t	df	ig.(2-taild)	differnce	differnce	Lower	Upper
Errorr	Equal variar assumed	7.117	.015	-2.437	20	0.24	-2.18	.895	-4.049	-314
	Equal variar not assumed			-2.437	10.378	.034	-2.18	895	-4.167	-197
Time	Equal variar assumed	6.494	.019	-1.820	20	.084	-883.18	485.131	95.148	28.785
	Equal variar not assumed			-1.820	10.421	.097	-883.18	485.131	58.231	91.868
Ease	Equal variar assumed	15.156	.001	-6.500	20	000	-1.18	.182	-1.561	-.803
	Equalvariar not assumed			-6.500	10.000	.000	-1.18	.182	1.587	-.777

rating of the E-System. The likert scale used in the rating used 1.0 as easy and 3.0 as difficult. Thus, the E-System average of 1.0 represents that the system was Easy-to-Use. The Manual System rating of 2.18 does not mean that the system is 100% difficult; but it does mean that it leans more towards difficulty than to ease (72%).

The differences were also calculated statistically using a t-test and all differences were significant at the 95% confidence level. Some of the results are shown in Table 2.

A Comparison between the Manual System and the E-System, where $\alpha = .05$

Qualitative results were collected during usability testing of each of the final system tasks. The data was provided by the Academic Affairs employees. Several advantages of the electronic system were

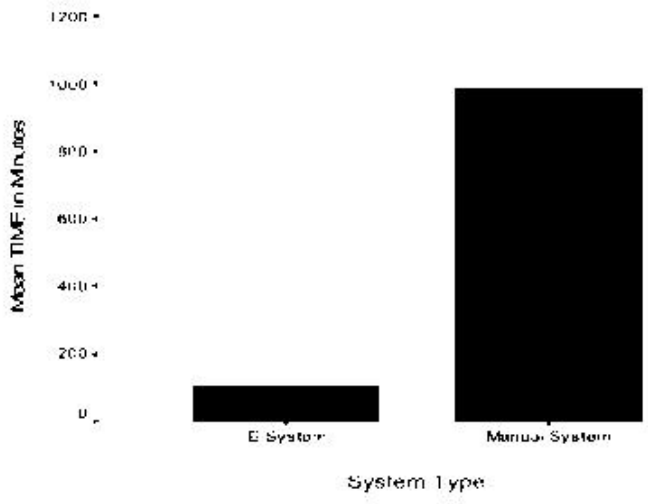

Fig. 2: Comparing time for task completion based on system type

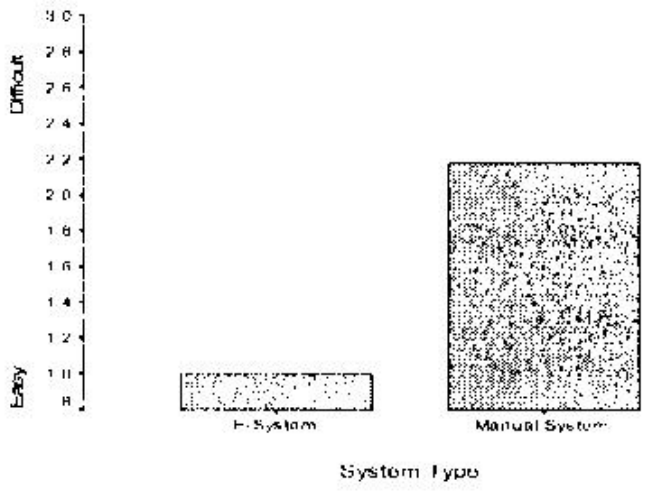

Fig. 3: Comparing ease of use Based on system type

listed by the staff. In fact, the advantages reported were far more than the disadvantages. "Ease" of use was reported in most tasks. Comments relating to faster task completion, improved accuracy and fewer errors in the electronic system were also very common. Other benefits reported were related to reduction in paper use, producing statistics, saving students efforts and enabling them to submit requests from off-campus, enabling stronger governance, compliance to rules, fairness, and improved functionality. Disadvantages reported were mainly related to fear of technical problems.

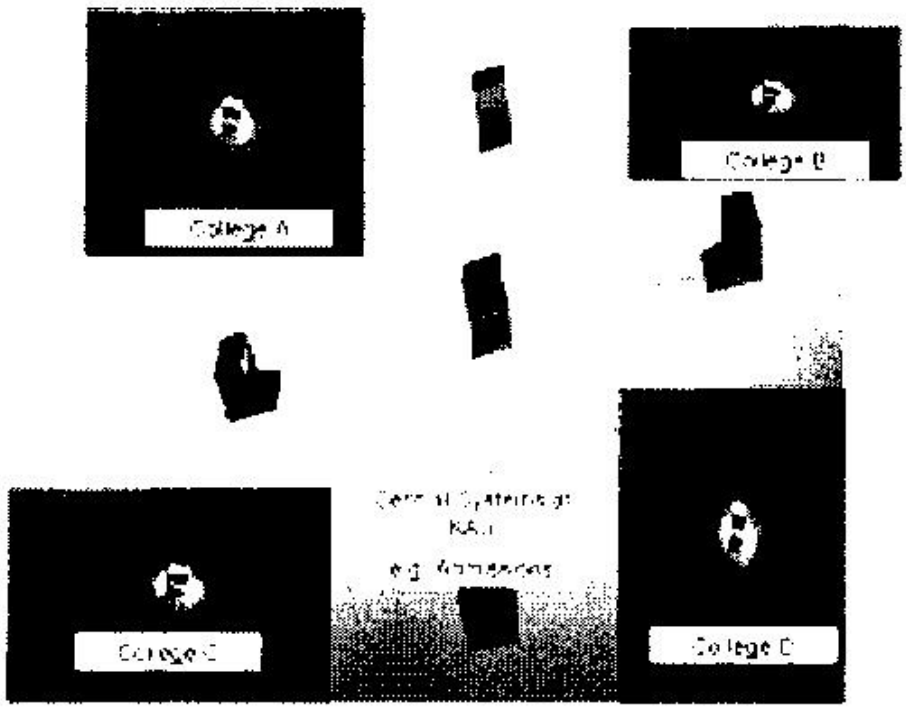

Fig. 4: KAU proposed hybrid architecture

DISCUSSION

Both quantitative and qualitative results gathered in this experiment are evident of the benefits of using an electronic management system in the Academic Affairs department in particular and in the college as a whole.

First, the quantitative results measured by time, number of errors, and ease of use, were all improved. The average reduction in time needed to complete a task was approximately 90%, when EAASy was used as apposed to the manual system, and on average errors were reduced by approximately 93%. Furthermore, performing tasks using the manual system was approximately 72% more difficult than when using the electronic system. Differences were also tested for significance at the 95% confidence levels, and were found to be significant.

Second, using the qualitative data gathered during the experiment, it is apparent from users' comments, that the benefits seen by the Academic Affairs staff are remarkable. Far more advantages were reported using the E-System than disadvantages. In fact, the very few disadvantages reported varied in type from person to person. For example, one employee reported a concern about the use of technology and what will happen if the system halts, which was not an actual disadvantage of the running system. This is a legitimate fear, and a backup plan needs to be in place once the electronic system is running. A few comments reported by users as disadvantages were actually enhancements that can be incorporated in the system.

Obstacles

While carrying out the research, several obstacles were faced by the Research Team.

As CCIT was a new startup college, several of the tasks were not very clear to the newly employed administrators which required a lot of investigation and learning on their part.

Furthermore, many of the managerial procedures were not documented yet. This required a big effort on the administrator's part in documenting the procedures. Normally such tasks require dedicated administrators for the job and require several months of hard work.

Furthermore, as the research took place in the college administration offices, busy schedules of employees were another obstacle that was faced by the Research Team. This made the task of data and information gathering difficult and time consuming as the Research Team worked around their busy schedules.

Another major obstacle that the Research Team faced was the fact that they were unable to gain access to the University central student database. This obstacle led the Research Team to develop a local student database. The database is currently being populated by the College students and the Academic Affairs themselves.

Being unable to gain access to the University servers was also an obstacle for the Team. The team was hoping to be able to run the developed system using the servers. However, due to University restrictions, the researchers contracted a public Internet Service Provider (ISP) to host the system using the ISPs servers, as purchasing and setting up a server was not possible due to the limited research resources (time and funding).

The final stages of the project, including usability and user testing stages, coincided with student registration. This was the period when the College was converting the old Computer Science (CS) single plan to the three new College plans, and as the students were being transferred from the College of Science that hosted the old CS Department to one of the three available plans in the new CCIT. As in any such transitional periods, the Academic Affairs department was facing several difficulties and all staff members were overwhelmed with troubleshooting and in some cases manual add and drop for students. The coinciding times were a huge problem as the coordination between the Research Team and the Academic Affairs was sometimes impossible.

Despite all the above obstacles, the Research Team was fortunate to be able to complete the work on time. No major modifications to the original proposed plan were considered nor took place during the entire research.

Conclusions and recommendations

Results from this research are very important. Proving that the electronic system is effective and improves performance within the Academic Affairs department, one of the most important units within any college, provides strong grounds for automating managerial tasks within colleges. The dramatic decrease in the time needed for task completion and the decrease in the number of errors, coupled by the reported ease of use of the System, are evidence that moving forward to fully-automated college managerial systems will be rewarding. These findings are inline with other research in which EMSs were found to provide such benefits (Owens & Sheldon 1999). Other benefits such as the reduction of paper use and manpower cost and improving performance measurement and auditing are also expected.

This research proposes KAU use a "hybrid" solution, or a combination of a centralized and a non-centralized solution (Von Simson 1995), as shown in Figure 4., in which applications needed by the different clients (in this case other campuses and different colleges) but do not need to be placed on the central DBMS be decentralized, while applications that are used by all clients, and need to use the central database, remain centralized. Applications such as academic affairs applications that are particular to each college are distributed at their local servers. The use of a distributed DBMS enables local DBMS to connect to the central DBMS and to other local DBMSs in the event they need any information, such as querying the central DB for employee records or course lists of other colleges. This will also allow for updates and maintenance to be performed remotely, resulting in reduction of operational cost.

However, in order for a successful implementation, several requirements need to be

satisfied. First, a sufficient background in computer use is required by all employees. Second, a strong infrastructure, including hardware, network communication, security measures, and technical staff to upgrade, maintain and run the system smoothly and securely, is needed.

Normally, one of the key obstacles that face people when new technologies are introduced in an environment is the negative attitude of people towards computers (Nickell & Pinto 1986) and their anxiety and fear of their use (Chua, Chen & Wong 1999; Heinssen, Glass & Knight 1987). It is important to mention that all Academic Affairs employees at the Women's CCIT have been given ICDL training by the College. ICDL training includes providing people with skills that enable them to use computers effectively. These skills have likely prevented Academic Affairs staff from demonstrating fear of technology.

As for the needed infrastructure, security is one of the key topics that need to be taken into consideration if a complete implementation is to take place. Security is an item that was out of the scope of this project, as the originally proposed system was to be run internally in the College. However, with the proposal of new processes, such as the student add and drop system, the required off-campus access from home, and the interface with other centralized databases, security should be a concern and the appropriate measures should be put in place if that part of the system shall be added in the future.

Providing the above are all important. However, the benefits achieved through a full implementation should outweigh the cost of the implementation.

In addition to achieving its direct goal, the project also yielded other benefits which include the methodology which can be used for the automation of other tasks within KAU and the procedural handbooks.

The scope of the project included the comparison of completing certain tasks in the Academic Affairs department using both a traditional manual system and an automated electronic system. Comparisons of efficiency were made based on the number of errors that may be conducted while completing a task, the time needed to complete a task and the opinions of users of the systems. Comparisons did not, however, take into consideration other factors that may influence system operation, such as technical difficulties that may occur if the electronic system was implemented or user experience and attitude towards computers. Other benefits of the E-System, such as the reduction of paper use and manpower cost and improving performance measurement and auditing would most likely be seen from an entire automation inside colleges.

However, to improve the automation of the colleges, this research calls upon the KAU Higher Administration to look seriously into automating tasks within colleges. Although, current efforts of KAU are to improve centralized systems, and although it may be a future plan for KAU to focus on more specific college automation needs, the researcher believes that both projects can be run in parallel, as seen in this project. The two projects will not overlap at beginning stages. However, eventually there may be some intersection points. For example, enabling the final exam schedule system within the college to read the master exam key produced by the University Deanship of Admissions can become automated by tying both systems, the College System and the Central University System. Thus, a hybrid architecture where certain databases and queries intersect can be used.

The research team hopes that, however minute the benefits from this work are, that it will benefit their beloved King Abdul Aziz University in general and their college, the College of Computing & Information Technology in particular.

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