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Impact of Academic Information Systems on the Performance of the Higher Education Institutions

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ABSTRACT: Information systems are becoming increasingly common and form an important part of public and private spheres of our society. Their ubiquity is helped by the advancements in computer technology in the last couple of decades which has made it possible for complex information to be managed in a transparent manner. The use of information systems in higher educational institutions such as universities has grown in recent years because of the enhanced capabilities of information systems in handling complex information in a sophisticated manner for the purpose of querying, retrieving and presenting information to advanced users. These academic information systems are reshaping the dialogue on knowledge sharing and creation in institutes of higher education. This paper traces the history of information systems and how academic information systems developed out of enhancements in computer technology. The paper then discusses the current research in the area of academic information systems which includes examples of academic information systems implemented successfully and also the challenges faced by stakeholders managing such systems in academic institutions. The paper concludes with a summary of the development of academic information systems and the potential future directions that they could take.

Keywords: information systems, academic information systems.

INTRODUCTION

The era of information started with the informal communication techniques that early man developed in order to share knowledge with his fellow humans, in the form of abstract symbols, signs and onomatopoeic sounds. In time, this form of communication advanced further as abstract sounds began replacing the actions and gestures that earlier systems of language had developed. Over the millennia, the form of language changed and advanced significantly to the present day languages which are capable of expressing sophisticated human thought with great accuracy. What originally began as a method of sharing operational intelligence in activities such as hunting, farming and community building became more versatile and allowed expression of more complex ideas and information. The origin of writing was the next massive leap in information management as it allowed preservation of ideas for a far longer duration than spoken information. The culmination of all the advances in science and technology afforded by writing has resulted in the development of computers and information systems in our modern era. The user of information systems to manage raw information as well as to provide processed information/knowledge has expanded to all spheres of public and private life in our society. The focus of this paper is on the use of academic information systems in universities. The paper starts with a discussion of the evolution of information systems and how they have affected the academic sphere, especially at the university level.

HISTORY OF INFORMATION SYSTEMS

A discussion of the history of information systems is not complete without a mention of the history of computers. This is due to the fact that computers form the underlying basis of modern information systems. The first modern computers were very rudimentary in capabilities in comparison to the current technology, and had very basic processing units with little to no storage available. The usage of such systems was limited to basic arithmetic calculations with no potential for any more complex processing. Despite the limitations in hardware technology, the systematic production of computers was made possible due to fundamental components such as vacuum tubes and later, transistors and IC chips. Some of the early computers such as the LEO I, UNIVAC I and Ferranti Mark 1 were influential in the development of more advanced systems and research into the use of information technology in various fields (Ceruzzi, 2003). With the increasing usage of transistors in constructing computing systems, more powerful computers such as mainframes became available which made it possible for sophisticated software components to be developed for the first time. Mainframes formed the basis for the first basic information systems developed for large government agencies and enterprises (Headrick, 2000). These systems were designed exclusively for the purpose of managing transactional information which is highly structured. An unintended consequence of this design limitation is that mainframe-based information systems are often much more robust and reliable in operation. Systems such as these are in use in high-demand

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applications such as railway and flight ticket information systems.

A turning point in the history of information systems came about with the rapid advancements in storage technology. According to Stockwell (2001), the amount of storage capacity in computers has skyrocketed when the meagre storage capacities 0of floppy discs are compared to the modern USB flash drives and portable storage media. In the early days of information systems, the type of information stored was transactional because of the severe limitations imposed by the limited storage capacities. In the late 1980s onwards, the computing capacity of processors used in personal computers increased exponentially allowing applications to process multimedia information, such as visuals and audio. This advancement resulted in the rapid growth in storage capacities in memory devices such as hard drives. The side benefit of this development was the improved capabilities made available to information systems in storing different types of digital information. The biggest leap made by information systems was due to the increasing adoption of the Internet among the general public. The opening up of this vast communication network made it possible for information systems to be distributed and be more scalable, performing and reliable due to the redundancies and economies of scale offered by modern cloud-based storage solutions. Modern search engines such as Google rely heavily on distributed information systems in order to provide the same quality of service to users no matter where they are located in the world. This is possible due to advances in computing such as software as a service (SaaS) and infrastructure as a service (IaaS) (Rayward and Bowden, 2009).

ACADEMIC INFORMATION SYSTEMS

The application of information systems in various aspects of public and private life has advanced to a large degree because modern information systems are reliable, performing, scalable, and responsive in the types and size of information they can manage. A major focus area of information systems in recent years has been in the domain of academic information systems. Higher education institutions such as colleges and universities are increasingly making use of information systems to support their service mandate of providing high-quality education to their stakeholders, i.e. students. Institutions such as Columbia Presbyterian Medical Center in the USA have invested in academic information systems in a big way (Clayton, Anderson and McCormack, 1991). The purpose of information systems in such institutions is to provide comprehensive medical knowledge is offered to nurses and physicians all over the campus by using a specialised information system that also combines with other transactional systems used for patient management. This kind of collaborative operational engagement was one of the first forms of implementation of academic information systems. According to the authors of the study quoted above, the concerned institution realised a significant amount of annual savings by implementing the academic information system, because of the great reduction in errors committed by physicians and high quality medical information available at all times. The conclusion of the study was that one of the important characteristics of academic information systems is the high initial cost of implementation but the accumulated benefits over a period of time outweigh the costs.

The underlying architecture of most academic information systems is similar to the standard enterprise information system architecture with some important variations. In most common information systems, the components of the system are situated within the physical confines of the organisation because of the immediate availability of licensed commercial components which could be strung together to form the information system architecture. In the case of academic information systems, the organisation may not have access to licensed components at all levels of the institution. Furthermore, the organisation could be distributed across several physically separated campuses which could further hinder the use of standard components without significant investment for a system-wide architecture. As such, the organisation may be forced to piece together components from different vendors or even open source technologies in order to build a viable information system (Yu and Chen, 1998). The authors of the study note that widely used platforms such as Java are preferable to older technologies such as CGI as they are not only technologically superior but also more affordable. The object oriented nature of the Java language and advanced features such as remote method invocation (RMI) allow for better communication between client and server levels. As there is no need for middleware to broker the communication between the different levels, the system is easier to design. In the study quoted above, a prototype academic information system was developed using Java at the National ChiNan University and reported significant improvement in performance using traditional CGI-based systems.

One of the important requirements of academic institutions is to be able to query information in a non-linear manner. Commercially used information systems such as transactional information systems typically provide well-defined, linear forms of accessing information which is contained within the system. Often, the information queried by researchers in an academic information system does not follow a linear pattern and may be complex in nature, as the information sought would often be defined in vague terms (Pienaar, 2007). In such cases, a simple query might not be employed; it could involve a combination of searching through an index of terms, textual query, visual query etc. The implication is that an academic information system must be capable of handling such varied search techniques in order to meet the needs of its users. The study validated this hypothesis by performing a qualitative research study at the University of Pretoria. The result of the analysis was that most of the survey respondents in the study preferred an academic information system which was capable of handling complex queries comprising various forms of search methods. One of the conclusions of the study involved the use of a web portal formed of many different

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methods of entering the system's query functions using an effective interface mechanism for aiding the information query needs of the relevant user base of the system. This research study corresponds to the empirical evidence of the familiarity of standard website portals such as Yahoo.com which promote the advanced querying to be conducted easily.

Despite the fact that academic information systems are often seen as digital collections of knowledge, they also meet other objectives. A common objective of academic information systems is to offer accurate operational intelligence to managerial stakeholders in higher education institutions such as university or college. In such systems, an academic information system functions as a decision support system. Such a system may co-exist with a more knowledge-oriented sub-system so that it provides both transactional intelligence while also providing useful knowledge to content creators and instructors. Such systems are analogous to the decision systems employed at enterprise organisations where they are used by senior management officers in a business function. A typical use case of such systems is in public libraries and bookstores where operational decision process and knowledge sharing may simply be two aspects of the system (Sastry, 2007). Because of the complex nature of such systems, they differ widely from enterprise information systems even though their mission goal may overlap, i.e. to provide transparent access to information to users within the organisation. Despite such overlaps, academic information systems are beset with unique needs such as low-cost and licence-free software and hardware components, having to support stakeholders across a wide geographic network and automating systems wherever necessary in order to reduce manual intervention and limit costs as such. In addition to these requirements, such systems must also support academic managers to make decisions. Such complex needs cannot be adequately met by commercial or off-the-shelf products which is yet another reason why academic information systems must be designed and developed *in situ*.

CURRENT RESEARCH

Information systems are increasingly being adopted in various industries and enterprise organisations due to the unparalleled benefits they offer compared to other kinds of information management. They have been attributed with enhancing the productivity and efficiency of organisations and act as a catalyst in sharing information without much effort leading to a better performing organisation. Nowadays, they are used in higher academic institutions to assist in their main goal of managing and sharing information. One of the earliest applications of information systems in the academic domain is digital libraries. According to Thong, Hong, and Tam (2002), empirical studies have established that most users of such libraries do not prefer using such resources in the same manner in which current research has proposed technical models for sharing the same. The main problem behind the relative lack of success in such methods is the fact that acceptance measures among the user community have not been assessed in a scientific manner. The authors in the study propose that utilising the technology acceptance model (TAM) will be useful in understanding the lack of serious adoption of academic information systems among the intended user base. On the basis of an assessment of the various contexts for system usage and the perceived ease of use of the system among the intended users, it was determined that the characteristics of the interface and variations in personal preferences form the basis for lack of usage of such systems. The other major research conclusion from the study was that the perceived usefulness and ease of use also determine the user acceptance of such systems.

In various research studies on usage patterns of information systems in academic institutions, it has been determined that system user acceptance was dismal in spite of efforts to render the system usable and enhance its attractiveness for ease of use and perceived value. Despite having received technical training, most users of such systems did not produce usage patterns that were expected on the basis of predictions in the research. Some of the most important reasons for the lack of acceptance were attributed to organisational issues such as the hesitance to accept new technology, socio-political factors inside the organisation which posed problems for the acceptance of new types of information access, changes in organisational information sharing patterns and little awareness of organisational issue management (Ash, 1997). The study notes that most managers responsible for incorporating academic information systems were often unaware or lacked adequate training in managing issues within the organisation that prevented the effective usage of such systems in their organisation. In her conclusion, Ash suggests that one of the primary steps in incorporating academic information systems must be the relevant training of top-level managers who are responsible for the implementation of the system in their respective organisation. The focus of such training should be on anticipating potential issues in the implementation of such systems such that any organisational impediments may be dealt with effectively and in a pre-emptive manner. This kind of measure could definitely have a significant impact on the perceived indifference to academic information systems among stakeholders within the organisation.

An important focus area of academic information system application is in medical research institutions such as hospitals and medical colleges. Among academic institutions, medical institutions hold a special place because students practice their acquired skills at a professional level while still studying at the institution. Besides, the risk to clients in the professional practice in such institutions is grave as patient lives are at risk subject to human error on the part of the physician-student. Even when patient treatment protocols may be well-defined and there may be secondary supervision of treatment provided by student doctors, the lack of complete educational information may hamper prompt diagnosis. In addition to this risk is the fact that the medical field undergoes rapid changes and newer information is continuously accreted

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which must be learned by the practitioner as part of his or her job. In a typical hospital situation, physicians would learn new knowledge by subscribing to medical journals or magazines. In the era of computers and information systems, it is now possible to deliver this information on-demand and instantaneously. At a major hospital in New York, the use of a medical information system, which comprised academic information modules, was credited with reducing the number of accidental diagnoses and with saving lives which may have been lost due to error in healthcare (Massaro, 2005). The author of the study also mentions that the other major benefit of the medical information system was that patient care costs were reduced significantly because of the greatly reduced cost of delivering educational reports to practitioners at the medical institution.

It has been claimed that the use of academic information systems improves the performance of organisations but the objectivity of this hypothesis has not been analysed extensively. In a study on the organisational competencies and critical success factors (CSFs), Sabherwal and Kirs (2007) evaluated the relationship between these factors and how their relationship affected the organisational performance. More than 200 large academic organisations were selected in the study and were queried to assess the validity of the relationship. The organisations were selected on the basis of pre-selected groups of attributes such as the reputation, student body strength, size of the organisation and some other factors. For each of these groups, IT profiles were constructed on the basis of the expected utilisation patterns and perceived needs. The responses to the questions asked in the survey formed the basis for the development of these profiles. On the basis of a comparison of the current IT capabilities of the institution with the ideal profile developed for each group, the authors of the study were able to assess the validity of the relationship between the usage patterns of IT systems and the success factors of the institutions surveyed in the study. The important conclusions made in the study were that only those academic organisations which utilised multi-level academic information systems performed significantly higher on various parameters such as environmental uncertainty and perceived success in IT. Although, the authors of the study note that the vast majority of the survey institutions were well-established large universities which have a history of successful IT implementation, even small academic institutions could realise great benefits by implementing academic information systems.

Academic information systems are often used as a tool to improve academic performance in higher educational institutions. There may be other valid reasons for implementing academic information systems as well. In a major study that surveyed ten large British universities, the reasons for adopting academic information systems fell into three major categories – operational information management, academic performance and knowledge management (Trowler, 1998). Knowledge management was indicated as the prime reason for implementing academic information systems out of these three categories. According to the study, despite the fact that academic performance is commonly attributed to as the main reason for implementing academic information systems, it is knowledge management which indirectly results in the improved academic performances and thus is the real reason for adopting academic information systems in large universities and other such institutions. The fact remains that even though information systems have been employed in the UK and other Western countries for the last four or five decades, only in the last one or two decades has the academic performance improved perceptibly and this is largely due to the fact that only recently have information systems have become powerful enough to offer knowledge management capabilities. According to the author of the study, there is a strong positive correlation between knowledge management and improved academic performance in the universities surveyed in the study. This is explained by the fact that better knowledge management capabilities in the academic information system provides greater opportunities to students to explore and acquire knowledge at their convenience.

The problem of intellectual property rights is an issue of prime concern for administrators of academic information systems. The information contained in most academic information systems such as copyrighted material in digital libraries, such as textbooks, trade and technical journals, and reference books. These publications are priced in the general marketplace and are provided to higher educational institution for fair use purposes. In traditional libraries, these were almost always in the form of published material which made it difficult for systemic unauthorised duplication due to the limits of the existing technology and the quality of the copying operation. In the example of digital publications, the knowledge can be duplicated in a lossless manner and multiple times due to the copying of digital information (Plummer, 2008). This feature makes it possible to duplicate information in an easier manner and thus increase the possibility for information to be copied digitally in academic information systems. Without necessary safeguards such as a combination of user authentication information and multi-level information access protocols, the intellectual information within a system would be compromised in a serious manner. A possible safeguard that could be incorporated in taking care of such confidential information is to protect communication networks and encoding the transmitted data in order that it may not be intercepted by malicious entities on the way to the intended recipient. Without the need for such protections, higher educational institutions run the risk of damaging opportunities to share copyrighted information and constrain the use of academic information systems ultimately not succeeding in the organisational mandate.

Academic information systems should be designed to protect the privacy information of its users and make sure that information specific to users does not reach the wrong destination. It is important to make sure that the preferences of the user and individual activity is safeguarded with

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maximum security because if such information were to be unduly revealed, theft of such information would cause major problems for the concerned user as personal information could be misused to obtain access to important and critical online account information such as financial accounts. In the case of most identity theft situations, the personal details of the user are gathered for the express purpose of accessing a secure account protected by confidential passphrase (Hemon and Altman, 1996). Additionally, dangerous entities may resort to extortion of finances in order to not reveal confidential financial information in the public domain. The same may not necessarily apply to academic institutions as the relevant threat in that situation would be the loss of confidentiality of student information such as performance grades which could potentially be misused by malicious agents for financial gain and thus compromise the credibility of the academic institution in question. Most universities employ a mixture of secure encryption protocols and user authentication to ensure that confidential student information is only made accessible to genuine authorised users on the network. Besides these protections, institutions are also required by law to protect student information by means of regulations such as the Data Protection Act of 1998 enacted in the UK and federal privacy laws in the USA. These are more important reasons why academic information systems may be designed to take information confidentiality into account in their design.

As discussed above, the problem of information theft and loss of privacy is a serious issue for administrators of academic information systems in higher educational institutions. One of the dominant problems in academic information systems is the issue of information security and its protection. As mentioned in other studies, the necessity to protect student information is mandated by law. As a consequence, it is important that an academic information system ensure the highest level of information security to the private information handled by the system. Without the appropriate safeguards, the confidential information could fall in improper hands and has the chance for being misused. An institution such as a higher educational organisation must ensure that implementing a strong security policy that protects registered and authenticated users, such as administrators, educators or the students themselves; have access to the confidential information managed by the system. Modern authentication methods such as the Needham Schroeder protocol or the more advanced Multi-Level Security (MLS) model utilised in defence establishments could be used to incorporate user authentication in such information systems in order to stop unauthorised entry to private and confidential information (Snavely, 2012). Another possibility is to break down the information managed within the system so that even if part of the information were to be maliciously accessed, the loss of confidentiality could be controlled immediately and the security problems may be rectified in order to limit further revelation of private data. Many higher educational institutions commonly make use of regular security audits on their academic information systems to ensure that their security policies are working as designed and that the confidentiality is not compromised.

CONCLUSION

Sharing information is one of the main reasons for academic institutions to implement academic information systems. One of the important reasons for universities to implement knowledge management in their academic information systems is the value offered to students in acquiring knowledge. In a traditional information system, it is difficult to capture knowledge adequately because it does not fit the traditional definition of information as it cannot be defined in the same concrete terms as traditional information. A common definition of knowledge is that it is an interrelated and interconnected information which leads to new information or findings not immediately apparent from each separate piece of information that combines to form the knowledge in question (Tatnall, Osorio, and Visscher, 2004). In that regard, a knowledge management system can be said of as one in which stored information is managed as interrelated and interconnected within well-known constructs. In the context of academic institutions, knowledge management systems are slowly evolving from information systems and in turn are developing into information sharing systems. Such systems are allowing the users to not just consume information and knowledge, but also letting them to be creative and develop information rather than just query and collect information. This non-linear pathway of information sharing is much more effective than conventional academic information sharing which is more linear in nature, as it allows users to be more creative. The academic institutions evaluated in the study have attributed improved performance on the basis of knowledge sharing between the different stakeholders in comparison to the more conventional methods they made use of before shifting to the more comprehensive academic systems.

Academic information systems are continuously evolving and they are expanding into newer applications and forms which are continuing to push the limits of what information systems can do for organisations and their users. One of the major areas of growth for academic information systems is in distributed elastic information systems. These systems will be similar to existing distributed information systems but they will be robust enough to expand and respond to user demands. In other potential directions of development, academic information systems may develop organic information accretion capabilities where they may employ artificial intelligence algorithms to automatically acquire information from external sources and classify them in a logical manner, all while evaluating the semantic content of the information and constructing knowledge graphs to allow non-linear access to the growing information repository. These and many other possibilities exist for the future development of academic information systems and the significant contributions they will continue making to their institutions.

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