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Table of Contents

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A roadmap for an integrated university information system based on connectivity issues: Case of Turkey

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Abstract:

Nowadays, universities are highly in need of an integrated university information system (IUIS) to increase the efficiency and effectiveness of the business processes in university administration which are eventually getting complicated due to increase in student enrollment. In this study, it is aimed to propose a roadmap for an IUIS based on strategic, logical, physical, and organizational connectivity issues to fulfil this need. For this purpose, firstly literature survey has been done on connectivity issues and best practices of IUISs. Afterwards, a university in Turkey has been analyzed in detail and a roadmap for an IUIS is proposed as a case study. The IUIS in the proposed roadmap consists of various subsystems that are integrated through a platform. All the subsystems on this IUIS platform communicate with each other via web services and this platform is accessed by users through a portal. As the output of this study, the roadmap for an IUIS is recommended and explained in detail under the four connectivity issues.

Keywords: Integrated University Information System, Strategic Connectivity, Physical Connectivity, Logical Connectivity, Organizational Connectivity

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1. Introduction

Universities, due to huge production of administrative and academic information, face a lot of problems related to executive issues. In this context, running a competent university administration becomes very important to deal with these problems and advances in information technology (IT) can contribute a lot on the quality of these administrative services. On the other hand, associated with the use of IT, universities encounter a common problem due to the usage of various information systems that have different infrastructures which causes data inconsistency and redundancy and therefore difficulty in running up the business processes in university administration. To support the intraorganizational business processes within organizations effectively, the existing information systems must be integrated (Hasselbring, 2000). Therefore, all components of this integrated system should be fully standardized and compatible. Universities also need an integrated information system (IIS) to increase efficiency, effectiveness, compatibility between subsystems and to provide consistent data flow. The process of integration must be improved with introduction of content unification, standardization and information management integration in order to be closer to the knowledge society and globalization. This process of information and knowledge integration on university level will help in introducing standards for information collection, information dissemination and information management (Cabukovski, 2010). IIS pursues to systematize record keeping, categorize and aggregate transactions, and provide efficient and effective environment for the flow of operations and resources (Chapman, 2005). Some researches in the literature argue that IIS make traditional forms of control stricter, because operations and resources can be allocated and organized in a proper manner (Chapman, Khin, 2009 c.f. Orlikowski, 1991; Sotto, 1997). Although it is obvious that integration process helps to perform business processes smoothly, it should not be forgotten that in order to obtain a satisfactory IIS, all of the integration matters considered under logical, physical, organizational and strategic connectivity issues should be considered.

Although there are many studies emphasizing the importance of IIS, the limited number of studies in the literature attempt to draw a map for the whole integration process of university information systems (Poston and Grabski, 2001; Chapman, Khin, 2009).

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The aim of this study is to propose a roadmap for an integrated university information system (IUIS) based on connectivity issues for administrational needs. For that purpose, first a literature survey is conducted about the connectivity issues for an IIS and then about the best practices of IISs in universities. Secondly, a university in Turkey has been analyzed in detail and a roadmap for an IUIS is proposed as a case study.

2. Literature Survey

2.1. Background on Connectivity Issues for Integrated Information System

The most important dimensions of designing an IIS are strategic, physical, logical and organizational connectivity issues which are comprehensively discussed in following subsections.

Strategic Connectivity: In accordance with Tillquist (2012), it is indicated that strategic connectivity has an important role on the successful integration of business operations. In this manner, organizations should incorporate strategic connectivity through their electronic channels in order to disseminate information and knowledge among their organizations. At that point, it is obvious that organizations need a winning integration strategy. Persson (2009) states that organizations should know their existing technology inventory and decide on their organizational needs and organizational future requirements.

Persson (2009) introduces a five step model to gain a better integration strategy. The first step includes the assessment of organizational needs. In this step, organizational and partner growth, mergers and acquisitions should be considered by the organization. The second step says that organizations should determine what applications are being used and what their technical requirements are, because data are disseminated, read, and understood both internally and externally. Both current technology and staff inventory build the third step. This step is important that whether existing technological infrastructure and staff will handle IISs or not. The fourth step that covers security needs the assessment of both current and future security requirements. The last step is planning of the implementation of the organizational integration solution. It is stated that this step is important to transmit existing business processes in a controlled way.

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Moreover, Tillquist (2012) introduces three strategies for IISs: linkage analysis planning, critical success factors method, and investment strategy analysis. Linkage analysis planning focuses on relationships along the value chain and electronic channels. This analysis identifies linkages and relationships of the organization with other entities. The second strategy called as critical success factors suggests that elements that are critical for operations or exposed to important threat, should be identified within the organizational boundary. Lastly, investment strategy analysis says that a winning strategy should focus on the distribution of organizational investments and the implementation of information technology resources.

In the view of suggestions and information mentioned above, organizations should determine a winning strategy according to their technological requirements to integrate information systems along inside and outside of the organization.

Physical Connectivity: As indicated by Wainwright (2004), physical connectivity stays at the basement of the system integration process (Figure 1). By this perspective, major technical advances in operating systems, databases, network and communication technologies and standards, have all contributed to the adoption of the distributed client server technical architectures (Willcocks, 1997). Also, considering the IISs for universities, Wang (1988) states that the issues of multiple vendor machines and physical communication are inherent as long as information resources are dispersed across geographic locations, and independent of the infrastructure of the physical connectivity of the organization. Therefore, communication protocols need to be established (e.g., TCP/IP LAN) between different machines for encapsulating the machine idiosyncrasies.

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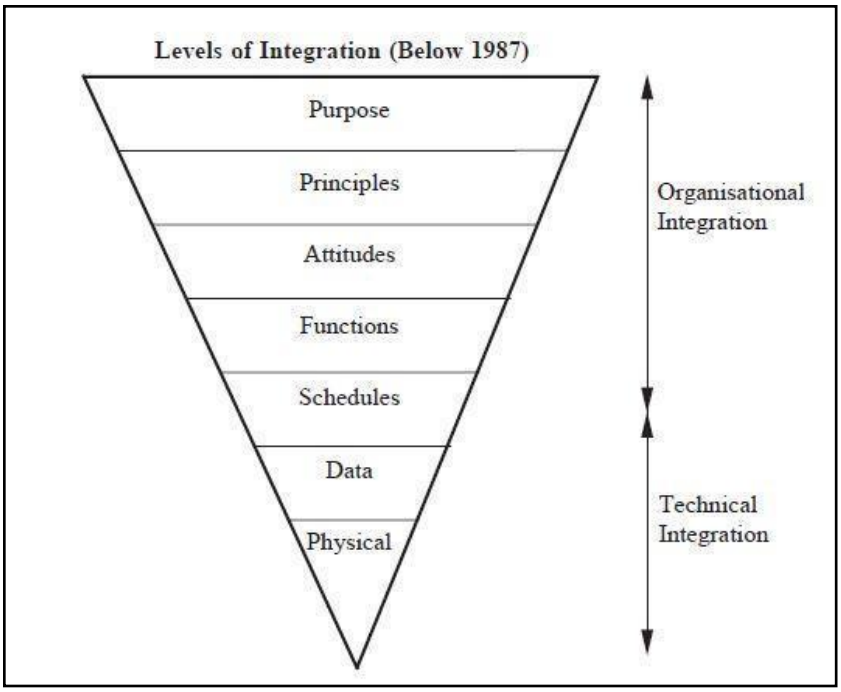

Figure 1: Levels of Integration (Taken from Below (1987) and adapted by Thomas (1991))

In addition to these, Lin (2008) states that web service, which can be defined as "a software system designed to support interoperable machine for machine interaction over a network", is another issue of physical connectivity of IISs. In order to conduct a proper web service as logical connectivity, it should not be forgotten that, there must be secure network design. Therefore, whether it is totally re-designed or a converted type, security should surely be provided over the subsystems of an IUIS. Due this fact, hard or soft firewall should be chosen.

Logical Connectivity: In an organization, there may be various information systems that should communicate each other. Several problems may arise related to this communication. One of them is the cause of data redundancy which is due to keeping the same data in separate databases of different information systems that have different logical infrastructure. In this point, it is vital to provide consistency between databases to make them communicate properly through logical connectivity. Logical connectivity is a concept in which schema level integration, instance level data semantics reconciliation, inter-database instance identification, and concept inferencing issues are covered (Madnick & Wang, 1991).

Especially organizations which use distributed database systems suffer from logical connectivity. First approach in logical connectivity is a schema integration, which is described as the activity

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of integrating the schemas of databases into a global, unified schema (Batini, Lenzerini, Navathe. 1986). Second approach is an instance level data semantics reconciliation, which solves the conflicts occur because of different definition of the same data instance (Ram & Park, 2004). Third approach is inter-database instance identification with two different methods; common key analysis and attribute setting. In order to apply third approach, there should be a common key which is defined in different databases in a similar manner to connect these databases properly (Madnick & Wang, 1991). Finally, concept inferencing approach can be used to solve standardization problem of the units by recording instances in the same unit (Madnick & Wang, 1991).

Logical connectivity can't be provided only by standardizing the database architectures but should also be applied to other components of the information systems. Service oriented architecture (SOA) is one of the approaches to integrate systems, applications, processes and businesses. SOA's goal is to accomplish loose coupling among interacting software agents (He, 2003). The SOA consists of one or more service requesters and one or more service providers and connect providers with the requesters via a bus (Conner & Robinson, 2006). Furthermore, SOA can be implemented by using web services which is also another integration technology (Erl, 2004). Web services are substantial for both automation of processes and data integration. Therefore it is inseparable part of logical connectivity together with SOA.

Organizational Connectivity: An organization is a social unit of people that is structured and managed to meet a need or to pursue collective goals (BusinessDirectory.com, 2014). Organizational readiness is an important success factor for change management process such as integration of all information systems of an enterprise (Kotter, 1995; Narine & Persaud, 2003; Rau, 2004). Weiner (2009) described organizational readiness as a shared psychological state in which organizational members feel committed to implementing an organizational change and confident in their collective abilities to do so. This way of thinking about organizational readiness is best suited for examining organizational changes where collective behavior change is necessary in order to effectively implement the change and, in some instances, for the change to produce anticipated benefits. According to Madnick (2002), organizational connectivity for IISs is pursued by understanding inter-dependency among strategic concerns, organizational culture, and technology. Strategic concerns require integration, whereas organizational culture

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requires autonomy for enterprises to be successful. Technology could solve this dilemma by providing integration, as well as autonomy at the same time. So the web services technology should be deployed for multiple system environments for enabling integration for top management without breaching the autonomy of departmental units. At the same time, guidelines and motivational activities in order to enrich organizational readiness for such a comprehensive change activity throughout the whole organization should be proposed.

2.2. Best Practices for Integrated University Information Systems

Kudrass (2016) declares that, the existence of heterogeneous software and the legacy information systems in universities has raised the need for the integration of these systems. Related to this need, there are various studies in literature that introduce applicable solutions for establishing well-designed IUISs.

Data consistency and accurate reporting which require database integration and access of data from a single authorized source are two main issues researched in previous studies. One of them, U-GOV, which was launched in 2005 in Italy, offers complete management of the main functional areas of the university with three main layers; database management systems, application server and web server as a solution (Bertazzoni, Ponti & Ravaioli, 2008). On the other hand, in the studies of Kudrass (2006) and Dimitriou et. al. (retrieved at June 9, 2014), web services and SOA were used simultaneously to build such a system.

In their study, Oliveira et al. (2011) focus on decentralization and expansion of higher education institutions by conducting a case study in a university in Brazil. They try to figure out how an information system makes a contribution to managing university expansion. At the end, it is indicated that using an IIS during university expansion increases efficiency and effectiveness.

Xiaolong et al. (2010) conduct a study in Tsinghua University and they present key technologies, scope, and construction thought for an IIS platform which consists of information portal, unified privilege management, data exchange, integrated information service, and information publishing.

Cabukovski (2010) presents a structure of an Integrated Agent-Based University Information System (IABUIS) which is developed for the Faculty of Natural Sciences and Mathematics in

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Skopje, Macedonia. The IABUIS is an e-university environment in a provision of agent-based e-learning concepts, technology and digital content unification, digital libraries standardization and information management integration. There are four main modules of the system: Student Administration Management System, Library Information System, Distance Learning System and University Management Information System. As a result, with a centered position Mediator agent, Supervisor, Level agent, User, and Expert agent are communicated with their own privileges properly.

Rodrigues (2003) introduces an Integrated Management Information System (I-MIS) which is developed and implemented in order to support an increasingly dynamic academic and administrative environment at the University of Mauritius. At the end of the study, following recommendations are given for IUISs:

- "End user requirements have to be fully analyzed and documented in appropriate preliminary investigation, analysis and design reports."
- "I-MIS end-users should clearly see the benefits that the system is bringing to their work."
- "University Management and Administration should be involved in the development of the I-MIS."

Bischof (2005) mentions the integration process of subsystems in the Aachen University in order to develop a properly working Campus Information System. This study mainly deals with redundant work, IT support ending on organizational boundaries, inconsistent data, and long winded processes. As a result, the main problems are indicated about web documentation and user friendly design and the solution for these problems is recommended as a necessity of reverse engineering.

IBM offers software "Websphere" for SOA environments that enables dynamic, interconnected business processes, and delivers highly effective application infrastructures for all business situations (IBM, retrieved at May 25, 2014). This system integrates different information systems via Websphere Integration Bus which is an enterprise service bus. Communication and data flow between information systems in the organization occur through this bus. Integration system consists of a layered infrastructure. In the most bottom layer there are application islands

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which are defined specifically for university use such as “Career Support”, “Budget”, “Acquisition”, “Research Portal”, “Inventory Stock” etc. Above this layer, there is a Websphere Integration Bus which connects all applications and provides data flow between applications. Above integration bus, there is a Websphere Portal where all user interaction occurs. One of the most advantageous parts of this system is that, existing information systems do not have to change their infrastructures, they only connect to integration bus and all processes work through it. Therefore, it is easy to adapt for both systems and end users.

SAP has been providing industry specific business solutions to higher education and research customers under the name of Student Lifecycle Management (SLCM), which provides a set of solutions to integrate and manage their end-to-end processes. This portfolio is supporting business processes for student records, student financials, recruitment and admission, student advising, academic structure, and class scheduling as well as academic services for teaching and research.

3. Methodology

The aim of this study was to propose a roadmap for an IUIS based on connectivity issues. For this purpose, two of the fact finding techniques of systems analysis; questionnaire and interview were used to examine the existing IT infrastructure of the university and also to determine the future needs.

Firstly, a short questionnaire was applied to each administrative department of the university to discover the portfolio of information systems and to have brief information for each of these systems.

Afterwards, a more detailed questionnaire was prepared, based on the previous studies in literature and on the suggestions of the IT consultant, considering the data collected through the first questionnaire. This new questionnaire was distributed to the related administrative departments of the university. This questionnaire aimed to collect data about the following items for the existing systems:

- General information
- Information about developer

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- Budget
- License duration
- Information about the maintenance
- Technical details
- Authorization
- Recommendations for future development

Some departments were IT-capable enough to answer the questionnaires by themselves, but nearly half of them required additional help from researchers, so separate meetings were scheduled with these departments, and the collection process of questionnaires were completed. The answers given to these questionnaires were consolidated under the supervision of the IT specialist to have statistical reports about the IT infrastructure and budget of the existing systems.

Furthermore, interviews with responsible staff were conducted to get their opinions about how to handle prospective resistances that academic and administrative personnel might respond to the changes that a new IUIS might arise. Consequently, their recommendation was to cooperate with university personnel during the integration project by taking their ideas through analysis meetings.

4. Findings

After applying the two systems analysis techniques it was determined that there were 17 separate subsystems which would be the basis of the IIS of the university. These subsystems were:

1. Student Subsystem: for registration services (school fee, courses etc.), dorm management, and scholarships
2. Personnel Subsystem: for executing payroll activities, personal affairs
3. Alumni Subsystem: for following up alumni information
4. Research Subsystem: for following up research projects and publications of academic personnel
5. Library Subsystem: for retrieving and accessing the published and electronic resources
6. General Services Subsystem: for keeping records of cafeteria, university car park etc.

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7. Medical Center Subsystem: for medical records of students and university personnel
8. University Community Facilities Center Subsystem: for keeping financial records and following up various facilities
9. Lifelong Learning Center Subsystem: for managing the records of continuing education activities
10. Communication Subsystem: for keeping records of telecommunication of university personnel
11. Budget Subsystem: for planning and following up of budget of all administrative units
12. Committee Management Subsystem: for managing the administrative issues of university committees
13. Procurement Subsystem: for keeping the acquisition records of university
14. Building Operations Subsystem: for keeping the records of maintenance and services at the university
15. Revolving Fund Subsystem: for keeping the records of revolving fund activities
16. Accrual Subsystem: for keeping the records of payments
17. Legal Subsystem: for following up any judicial case of university

The relationships and dependencies between those subsystems were analyzed, and to visualize the whole university administration system, package diagram was drawn as given in Figure 2.

One important issue raised during the systems analysis was the authorized access to all subsystems. In the existing settings, all subsystems used their own authorization mechanisms and therefore kept their user authorization data in their local databases.

On the other hand, a proper and consistent reporting capability that would consolidate data from different subsystems was the main request of the rectorate.

The last point stated by the interviewees was the insufficient network infrastructure of the university which occasionally got down.

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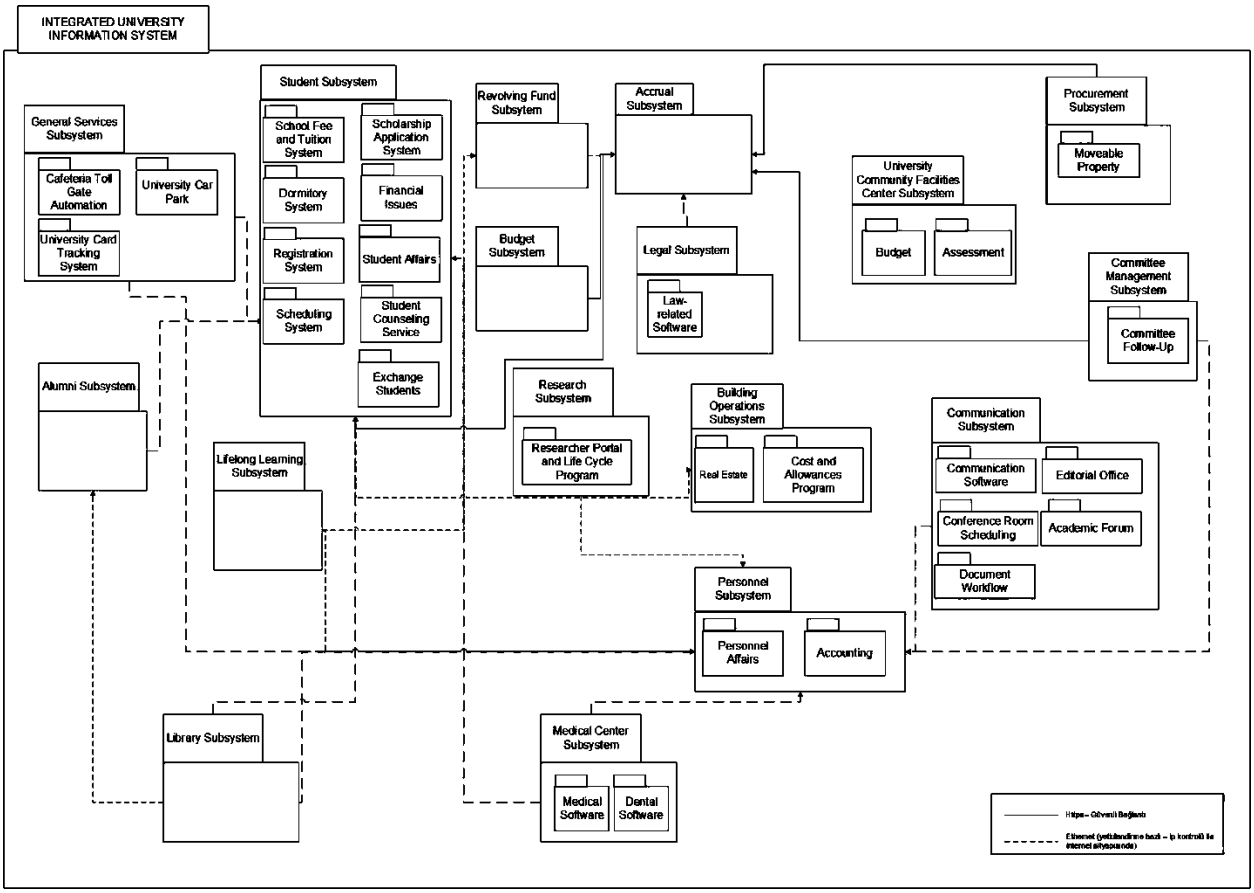

Figure 2: Package Diagram for the University Administration System

From the responses given to questionnaires and interviews, it was seen that within the university there were numerous information subsystems with different structures gathered in a very crowded way which need integration.

5. Recommendation

As the output of this study, considering the literature survey and the analysis findings of the university case, a roadmap for an IUIS, based on four connectivity issues is proposed with the related characteristics explained under each connectivity item.

5.1. Strategic Connectivity

The university experiences an organic growth, so the solution for the integration of information subsystems should be flexible. At this point, it is important that information and knowledge must be disseminated, read, and understood by all internal departments. University staff plays an

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important role for building an IUIS so it is recommended that they should be incorporated during the integration phase for the progress to be more effective and efficient.

For an IUIS, disaster recovery is also another important issue which should be managed by the main communication center (MCC). Therefore, an appropriate disaster recovery plan for the IUIS must be prepared within the strategic plan of the organization such as mirroring the databases.

In order to build up a successful IT strategy, critical success factors method can be implemented. For this purpose, firstly the critical elements and important threats within the university environment must be identified and then the strategic plan which would include risks, concerns, benefits, and communication plan should be prepared accordingly.

5.2. Physical Connectivity

The structure of the existing university network has been designed for providing communication only within each subsystem, but there is no communication infrastructure that connects those subsystems. Therefore, a new communication infrastructure should be designed under physical connectivity item, in terms of translating the messages from different subsystems in the top layer, standardizing the speed of connections, and providing security throughout the communication for an effective and efficient integrated system.

It is clear that, an IIS is not same with “collection of subsystems” since IIS needs highly available communication between its subsystems. Therefore, a simple communication protocol, which accomplishes the standardization of the messages through translation, should be provided over the subsystems. This translation doesn’t need to change the existing structure; it can be applied through adapters, converters, etc. installed for each subsystem.

The standardization of the speed of the system is an important issue for physical connectivity which needs consistent communication medium to provide efficiency. Since the backbone of the university doesn’t have the required infrastructure for a well-designed IUIS, upgrading the network infrastructure of the university should be considered which needs the renewing of cabling and related communication devices in some locations.

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Lastly, all subsystems should be subject to firewall security procedures, which require them to be kept behind the firewall in the network. In existing situation, some subsystems are not protected through firewall or the firewalls they protected are based on hard coded security procedures, which are not flexible for proposed IUIS model. In order to secure IUIS from cyber-attacks, it is recommended to change the existing firewall systems to a powerful soft one and to give the management of this firewall to MCC.

5.3. Logical Connectivity

Package diagram (Figure 2) can be considered as a guide for shaping the recommended logical view of the IUIS. Since there are so many subsystems, which need to work interactively, a SOA that combines the subsystems through web services is proposed. Student, personnel and alumni subsystems are lying in the middle of the connection highways that request and send information to other subsystems. Therefore, these three subsystems are the building blocks of an IUIS platform.

On the other hand, the authorization problem raised during the analysis workshops is recommended to be solved by integrating a Lightweight Directory Access Protocol (LDAP) server to IUIS platform.

Furthermore, building data warehouses through an IUIS platform extracted from subsystems is going to fulfill the need for proper and consistent reporting.

Details of these solutions are reported in following subsections:

SOA Logic: Logical connectivity of local systems will be provided with SOA approach. There are three parties to coordinate, namely student, personnel and alumni data on the IUIS platform, additionally LDAP authentication server will be responsible for accurate access protocol from University Portal. At the bottom of the platform, there will lie other local subsystems' databases such as publications, finance, procurement, medical treatments, etc. Figure 3 shows the logical connection between these parties.

The university web portal which has a graphical user interface for an IUIS should work through only one login for unified authentication. When a user tries to start a subsystem, the system redirects user to the login page of web portal.

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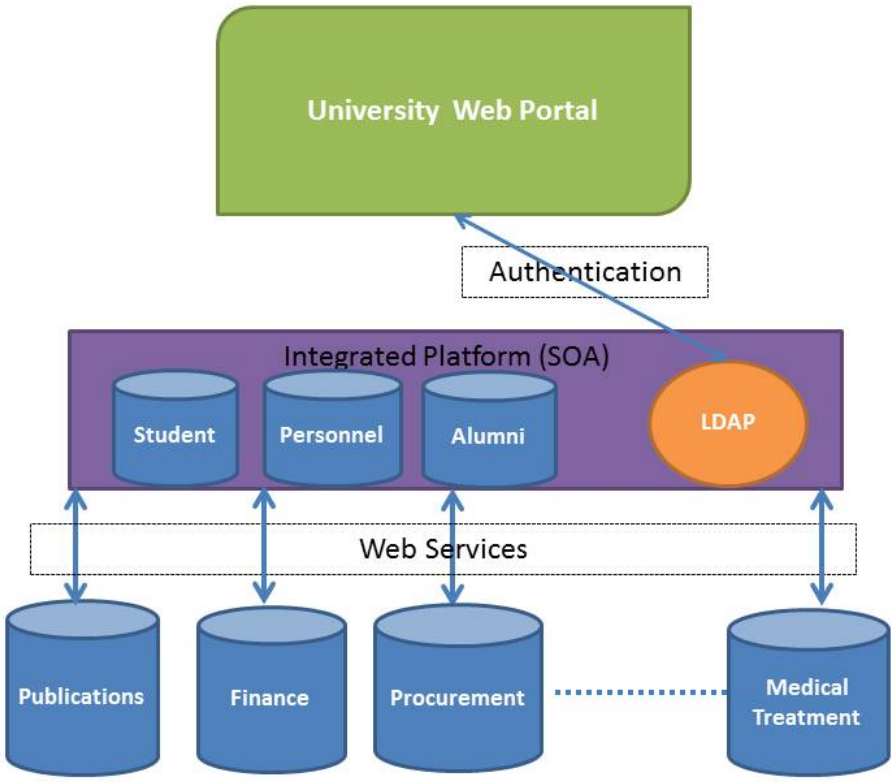

Figure 3: Logical Connectivity Diagram for IUIS

The homepage of the user which shows only the accessible subsystems based on user's privileges appears is given in Figure 4. The homepage is designed in a compatible form of tablet PCs where the subsystems the user has right to access are shown in rectangular buttons. Moreover, social network accounts are presented as iframes in the right pane. At the left pane, menu bar which consists of the Profile, Contact, Help and Logout links are placed.

Authentication Logic: Callback authentication mechanism has been chosen as login authentication method. The main authentication system will be administered by MCC, so that authentication mechanisms under local subsystems will be coordinated. System users will not need to login local subsystems separately, despite of having different user ids and passwords. When their login request arrives to IUIS platform, LDAP server interchanges the main login id to local id of the related subsystems, and enables the connection.

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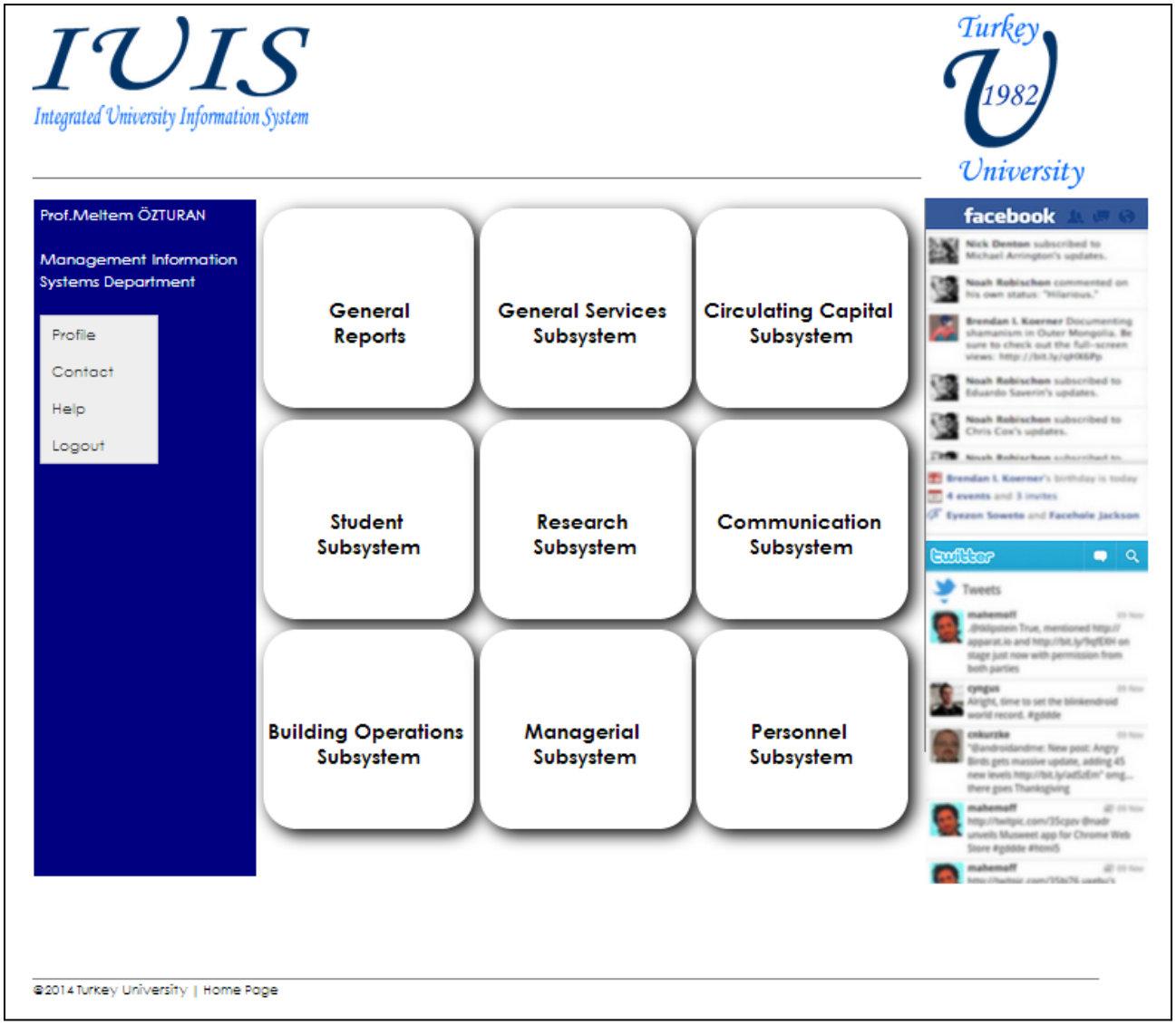

Figure 4: Home Page of Web Portal for IUIS

Communication Logic - Web Services: Web services are responsible for the logical connection between local subsystems and the main system on the IUIS platform. The subsystems that are the actual data owners of student, personnel and alumni databases are located on the main system of the platform. When data are updated on these databases, a daily web service is triggered by MCC automatically to retrieve only these updates and send them to other local subsystems. An authorized person is assigned to every local subsystem for executing the main system updates. Authorized person should check the updates and executes them if necessary for their local subsystem. Figure 5 shows the local database update workflow.

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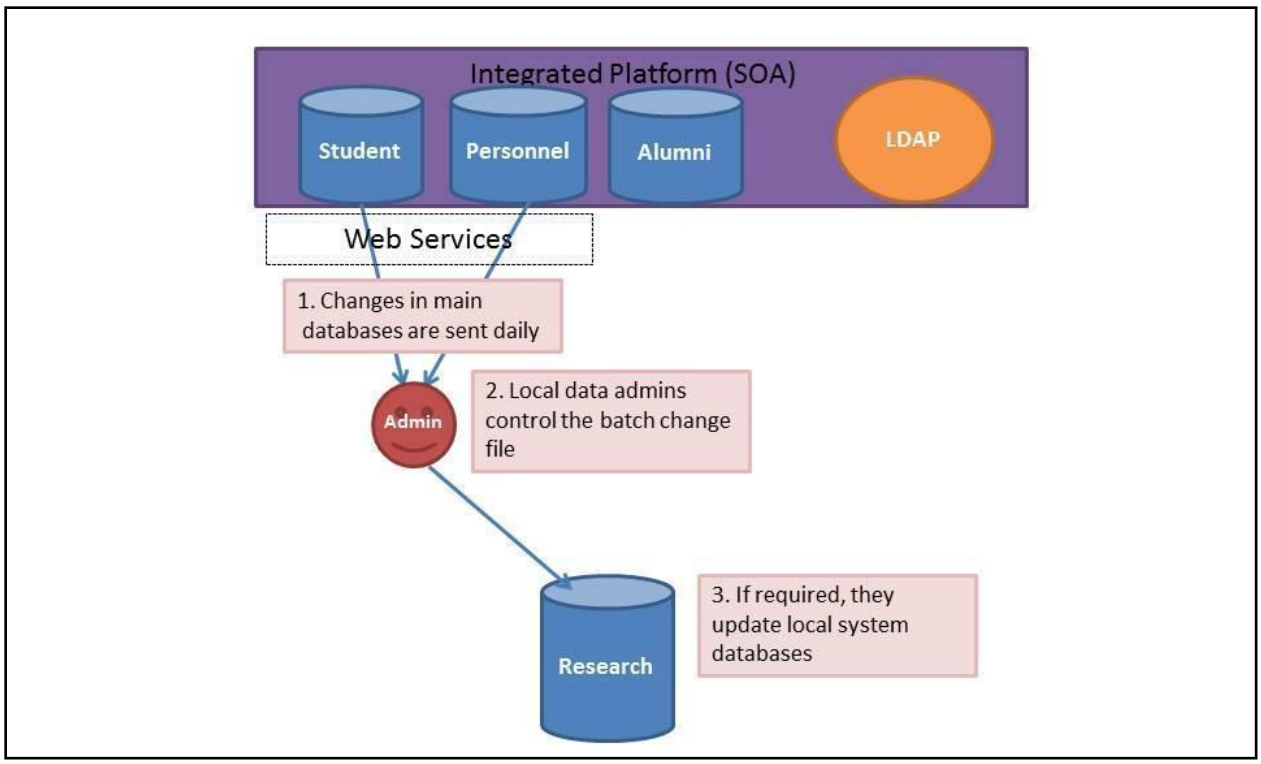

Figure 5: Local Database Update Workflow based on Web Services for IUIS

Web services are managed by MCC. They could schedule new web services, change web service trigger schedule, or change the content of files sent to local data administrators. In case of peak times of data transfer, such as student registration week, the batch data schedules should be updated hourly.

Reporting Logic: MCC of the university is responsible for the maintenance of the data warehouse built for the general reporting functions of IUIS. Users have access to those general reports from the portal page; moreover MCC specialists could generate special reports in order to fulfill the specialized needs of the university departments.

5.4. Organizational Connectivity

In order to achieve organizational connectivity, following strategies suggested by Weiner (2009) should be implemented carefully:

- Fomenting dissatisfaction with the status quo,
- Creating an appealing vision of a future state of affairs,
- Creating a sense of urgency,

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- Highlighting the discrepancy between current and desired performance levels,
- End-user involvement.

In the light of these suggestions, each administrative unit which will use this new system should be included in the integration process. The vision and the mission of the project, and the demand for their commitment for mutual success of the project should be cleared in the initial stage of the project. Additionally, the features of the IUIS platform should be introduced to university personnel in order to get their support to the project. The features should ease their daily operational work such as enabling single login to different subsystems. Thus, organizational readiness both for academic and administrative personnel for IUIS project will be enriched.

7. Conclusion

The common problem of universities is the existence of various heterogeneous information systems which cause data inconsistency and redundancy, and difficulty in application of business processes in university administration. Therefore, university information system needs integration in order to increase efficiency, effectiveness, compatibility between subsystems and to provide consistent data flow and four main connectivity issues, strategic, physical, logical and organizational, should be considered during this integration process.

The aim of this study was to propose a roadmap for an IUIS based on these connectivity issues for administrational needs. For this purpose, first, the related literature survey is conducted and then the existing information systems of the university are analyzed as a case study. Secondly, based on the literature survey and the findings of the analysis, a roadmap for an IUIS is proposed covering strategic, logical, physical, and organizational connectivity issues.

The proposed roadmap for an IUIS includes the followings;

- Strategic connectivity goals that guide the overall plan of the integration process.
- Three main physical connectivity subjects for a new communication infrastructure as translating the messages from different subsystems, standardizing the speed of connections and providing security throughout the communication for an effective and efficient integrated system.
- Use of SOA to combine the subsystems through web services and LDAP to provide

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authorized access and data warehouses to retrieve proper and consistent reports for logical connectivity

- Meetings with academic and administrative personnel to provide organizational readiness

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References

Batini, C., Lenzerini, M., & Navathe, S. B. (1986). A comparative analysis of methodologies for database schema integration. *ACM computing surveys (CSUR)*, 18(4), 323-364. doi: 10.1145/27633.27634

Below, L. J. (1987). The meaning of integration. *In Proceedings of the 4th European Conference on Automated Manufacturing*, 345-352.

Bertazzoni, N., Ponti G. & Ravaioli, S. (2008). Project U-GOV The new CINECA integrated information system for Higher Education. *EUNIS 2008 VISION IT - Vision for IT in higher education* June 24 - 27, 2008.

Bischof, C., Gebhardt, M., & Steves, P. (2005). The Integrated CAMPUS Information System: Bridging the Gap between Administrative and E-Learning Processes. *In 11th EUNIS Conference.*

Organization (2014). Business Dictionary. Retrieved on May, 19, 2014, from http://www.businessdictionary.com/definition/organization.html.

Conner, P., & Robinson, S. (2006). U.S. Patent Application 11/388,624.

Cabukovski, V. E. (2010, February). Integrated Agent-Based University Information System. *In Mobile, Hybrid, and On-Line Learning, 2010. ELML'10. Second International Conference on,* 36-40. IEEE.

Chapman, C. S. (2005). Not because they are new: Developing the contribution of enterprise resource planning systems to management control research. *Accounting, Organizations and Society*, 30(7), 685-689. doi:10.1016/j.aos.2005.02.002

ISSN 1923-0265 (Print) - ISSN 1923-0273 (Online) - ISSN 1923-0281 (CD-ROM), Copyright NAISIT Publishers 2015

Chapman, C. S., & Kihn, L. A. (2009). Information system integration, enabling control and performance. *Accounting, organizations and society*, 34(2), 151-169. doi:10.1016/j.aos.2008.07.003

Dimitriou, G., Milonas, T., Velonis,A. & Papazidis, G. (2014). Integrating Administrative Information Systems: The Case of Greece. Retrieved on June, 01, 2014 from http://www.cardisoft.gr/frontend/articles.php?cid=49.

Erl, T. (2004). *Service-oriented architecture: a field guide to integrating XML and web services*. Prentice Hall PTR.

Harness smart solutions to power your higher education or research institution (2014). SAP. Retrieved on May, 20, 2014 from http://www.sap.com/solution/industry/higher-education research/solutions/ software.html.

Hasselbring, W. (2000). Information system integration. Communications of the ACM, 43(6), 32-38. doi: 10.1145/336460.336472

He, H. (2003). What is service-oriented architecture. *Publicação eletrônica em*, 30, 1-5.

Websphere (2014). IBM. Retrieved May 25, 2014 from http://www-01.ibm.com/software/websphere/

Kotter, J. P. (1995). Leading change: Why transformation efforts fail. *Harvard business review*, 73(2), 59-67.

Kudrass, T. (2006, May). Integrated University Information Systems. In *ICEIS*, 1, 208-214.

Madnick, S. (2002). Integrating eSystems & Global Information Systems. Retrieved on May, 19, 2014 from http://ocw.mit.edu/courses/sloan-school-of-management/15-565j-integrating-esystems-global-information-systems-spring-2002/index.htm.

Madnick, S. E., & Wang, Y. R. (1991, January). Logical connectivity: applications, requirements, architecture, and research agenda. In *System Sciences*, 1991. *Proceedings of the Twenty-Fourth Annual Hawaii International Conference* on, 1, 142-153. IEEE. doi: 10.1109/HICSS.1991.183880

ISSN 1923-0265 (Print) - ISSN 1923-0273 (Online) - ISSN 1923-0281 (CD-ROM), Copyright NAISIT Publishers 2015

Narine, L., & Persaud, D. D. (2003). Gaining and maintaining commitment to large-scale change in healthcare organizations. *Health Services Management Research, 16*(3), 179-87. doi: 10.1258/095148403322167933

Oliveira, L.A.B, Vasconcelos, N., Queiroz, F. C.B. P., Queiroz, J.V. & Hékis, H.R. (2011). Contribution of Integrated Management Systems to University Management: Case Study of the Federal University of Rio Grande Do Norte. *Journal of social sciences*, 7 (3), 415-422.

Orlikowski, W. (1991). Integrated information environment or matrix of control? The contradictory implications of information technology. *Accounting, Management and Information Technology*, 1(1), 9–42.

1. Persson, U. (2009). Five Steps to Strategic B2B Connectivity. Retrieved on May, 29, 2014 from http://www.ebizq.net/topics/int_sbp/features/11390.html?page=1.

2. Poston, R., & Grabski, S. (2001). Financial impacts of enterprise resource planning implementations. *International Journal of Accounting Information Systems*, 2, 271–294.

Ram, S., & Park, J. (2004). Semantic Conflict Resolution Ontology (SCROL): An ontology for detecting and resolving data and schema-level semantic conflicts. *Knowledge and Data Engineering, IEEE Transactions* on, 16(2), 189-202. doi:10.1109/TKDE.2004.1269597

Rau, K. G. (2004). Effective Governance of IT: Design Objectives, Roles, and Relationships. *Information Systems Management*, 21(4), 35-42. doi:10.1201/1078/44705.21.4.20040901/84185.4

Rodrigues, A. J., & Govinda, S. (2003). Towards an integrated management information system: A case of the University of Mauritius. *Information Technology for Development*, 10(1), 41-56. doi: 10.1002/itdj.1590100105

Sotto, R. (1997). The virtual organization. *Accounting, Management and Information Technology*, 7(1), 37–51.

Thomas, P. S. (1991). Implementing computer integrated manufacturing technology—an integrative framework. Ph.D. Thesis, University of Northumbria, Unpublished.

ISSN 1923-0265 (Print) - ISSN 1923-0273 (Online) - ISSN 1923-0281 (CD-ROM), Copyright NAISIT Publishers 2015

Tillquist, J. (2002). Strategic Connectivity in Extended Enterprise Networks. *Journal of Electronic Commerce Research*, 3 (2), 77-85.

Wainwright, D. & Waring, T. (2004). Three domains for implementing integrated information systems: redressing the balance between technology, strategic and organisational analysis. *International Journal of Information Management*, 24(4), 329-346. doi: 10.1016/j.ijinfomgt.2004.04.01

Willcocks, L. P., Feeny, D., & Islei, G. (1997). *Managing information technology as a strategic resource*. McGraw-Hill Higher Education.

Weiner, B. J. (2009). The Theory of Organizational Readiness for Change. *Implementation Science*, 4(1), 67.

Xiaolong, F., Qixin, L. and Fang, Y. (2010). Design and Implementation of University Level Unified Information System Integration Platform, *In the proceedings of Computer Sciences and Convergence Information Technology (ICCIT)*, Seoul, 864-868.

ISSN 1923-0265 (Print) - ISSN 1923-0273 (Online) - ISSN 1923-0281 (CD-ROM), Copyright NAISIT Publishers 2015