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Information Management in a Collaboratively-Developed Approach to Enterprise Resource Planning—A Higher Education Perspective

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Abstract: This paper is a part of an exploratory study with the goal of investigating the applicability of collaboratively-developed enterprise resource planning (the CD-ERP approach) within Libyan public universities. Since it is being proposed in order to overcome the topical issue of information system (IS) development in Libyan higher education (LHE), Libyan universities were investigated to assess IS performance while using the approach of methodological assessment. Accordingly, three public universities were chosen to be studied, namely the University of Tripoli (UOT), Misurata University (MU), and Sirte University (SU). The UOT was run as an initial study to identify practical problems in conducting a formal study. Previous papers have discussed the use of a formal study, in which a methodological assessment of IS performance at Libyan universities was conducted. The findings from all three cases are discussed and analyzed on the basis of selected techniques and models. This analysis indicates the low level of the ISs implemented in LHE at the university level, as well as the lack of system development capabilities within these universities. This paper focuses on the management of information flow between universities during student exchange. Business process maps are presented, and improvements based on the CD-ERP approach are proposed.

Keywords: management; information workflow; CD-ERP; information system; quantitative analysis; data security

1. Summary

Based on the Global Competitiveness Report 2003–2014, which ranked national education systems, Libya placed 108th out of 148 countries providing higher education. It is clear that Libyan higher education (LHE) falls in the bottom third of the countries surveyed. Consequently, LHE has failed to achieve its goals [1]. It is increasingly being acknowledged that effectively using technology in higher education is a vital factor for providing a higher quality of education. The University of Tripoli (UOT) is one of the public universities in Libya that is seeking to increase the quality of the education it provides. The faculties at the UOT previously ran their own systems, which were developed separately [1–3].

The collaboratively-developed enterprise resource planning model (the CD-ERP approach) is based on an ERP system that is further developed by a consortium of higher education (HE) institutes. Since this approach is being proposed to overcome the topical issue of information system (IS) development in Libyan higher education (LHE), Libyan universities were investigated to assess IS performance by using the approach of methodological assessment. Accordingly, three public universities were chosen to be studied, namely the University of Tripoli (UOT), Misurata University (MU), and Sirte University (SU). The flow of relevant information is very important, especially in the case of universities that

are cooperating via the academic exchange of students. Hence, a case-study aimed at assessing the applicability of the collaboratively-developed enterprise resource planning approach is presented in this paper.

Section 2 describes the method of collecting data for the study. Previous studies of a similar nature are presented in Section 3. An analysis of the use of ISs to facilitate the activities of the universities that were studied is presented in Section 4. The concept that is proposed for the development of integrated ISs in LHE, the CD-ERP approach, is outlined in Section 5. In Section 6, the authors present maps of three processes that are involved with student exchanges that would be facilitated by such an integrated system. Conclusions are presented in Section 7.

2. Description of the Data

The methodological assessment that was applied in this study can be summarized as follows: The authors carried out multiple case studies where the subjects were the UOT, MU and SU. These three establishments are different in terms of their history. The inductive approach was appropriate in this study, since it involves qualitative research where researchers collect data and develop a theory on the basis of data analysis. Data collection was based on interviews regarding the level of Information and Communication Technology (ICT) in all three universities with an emphasis on the deployment of ISs. In order to study these universities in a consistent manner, the model of business activities in HE institutes from [4] was adopted, as illustrated in Figure 1. Data gathering and analysis were both based on this model. The case of the UOT was investigated as an initial study to test the research techniques. Later, a formal study took place. All the gathered data were analyzed on the basis of the techniques and models mentioned above.

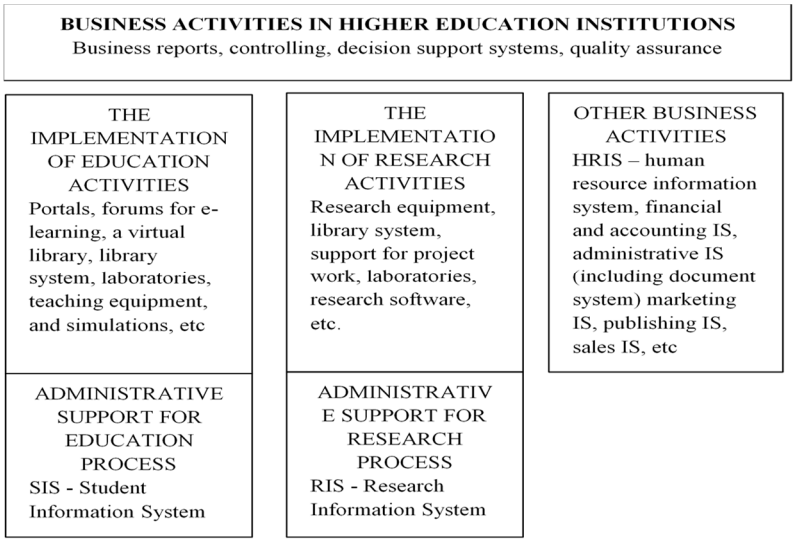

Figure 1. Business activities in a higher educational institution.

2.1. Data Collection and Analysis

The design of data collection and analysis of the target population were based on the concept of snowball sampling/respondent-driven sampling (RDS). RDS is a popular method of data collection in the study of niche populations that are small but have relatively strong links between members (Salganik and Heckathorn 2004) [5,6]. The use of snowball sampling in such cases has created a widespread perception of chain referral methods as methods of convenience sampling [7,8]. RDS combines "snowball sampling" (getting individuals to recommend colleagues as subjects, who, in turn, recommend other colleagues, and so on) with a mathematical model that weighs the sample to compensate for the fact that the sample was collected in a non-random way [9,10]. A method that combines aspects of both snowball and RDS sampling was used. Each respondent was asked to give an

estimate of the size of their network. This helped to decide whether to use interviews or questionnaires, a decision that depends on the estimated size of the network of the seed(s).

2.2. Target Population

The subjects of the case studies were chosen because:

- They are all Libyan public universities.
- Geographically, they are all located in the same region (Tripolitania Region) under the same regional government.
- They all require ICT development,.
- These three universities have different histories: The UOT is considered to be an institute with a long history, MU is a middle-aged university in terms of LHE, and SU is a relatively newly-established one.

2.3. Study Respondents

There were three participants from the UOT, who are labelled as T1, T2, and T3, who were interviewed as part of the initial study during August and September 2018 [11]. The formal study took place during June–July 2019. There were two participants from MU, who are labelled as M1 and M2, and three participants from SU, who are labelled S-1, S-2, and S-3. These participants were all interviewed in Libya. All the participants were experienced in the use, support, and management of ISs within their universities. The responses that were obtained from these respondents provided the authors with an understanding of the current level of the implemented ISs. Later, this understanding was discussed and analyzed on the basis of the selected models and techniques in order to assess the level of these ISs. A description of the respondents is given in Table 1.

Table 1. Brief description of the respondents who participated in the study.

Case Study	Respondents	Position	Years of Experience
UOT	T-1	Former Head of ICT Centre	5
	T-2	Head of ICT Centre	10
	T-3	Head of IS Department	7
MU	M-1	Head of ICT Centre	5
	M-2	Head of Programming and IS Unit in the Information and Documentation Centre (IDC)	6
SU	S-1	Director of ICT Centre	9
	S-2	Head of Programming and System Analysis Office in the Information Technology and Documentation Centre (ITDC)	5
	S-3	Director of the office for the design and management of SU's websites	3

In all the case studies, the respondents were first introduced to the study via e-mail. Then, they were contacted by telephone during the first session of the interviews. After this, a list of the additional information that was needed was e-mailed to them. Eventually, oral interviews took place. The languages used in interviews were Arabic and English for easier communication with the respondents. The length of these interviews was between 35 min and 2 h.

In the initial study, the participants from the UOT were interviewed six months before the formal study. Later, they were contacted by e-mail to check whether any changes or updates had

occurred during the period between the two studies (initial and formal studies). In the other two cases, the interviews were held in Libya during the summer of 2019.

3. Related Studies

Essentially, the applicability of the CD-ERP model to LHE was studied by examining both international experiences and the Libyan context. To the author's knowledge, this study is the first to deal with both sides. Little attention has been paid to international experiences of the communitysource approach. The studies that have been carried out on such projects have generally considered their technical issues, rather than the consortium itself. As mentioned before, consortiums between universities have existed for a long time, e.g., the CINECA project in Italy [12] that dates back to 1969, while the community-source paradigm was first applied by the KUALI [13] and SAKAI projects [14,15], in the United States. Other studies have been conducted on USOS in Poland [16], the Sigma Suite and the CRIS Argos Suite in Spain [17], the FS University Consortium in Norway [18], the AMUE system in France [19], Ladok in Sweden [20], and HisinOne in Germany [21].

On the Libyan side, Bakeer and Wynn carried out three studies on IS deployment in Libyan universities [22]. Unlike our study, in which multiple cases were chosen, Bakeer and Wynn investigated Misurata University as a case study. Additionally, they treated ISs and e-solutions alike, while this thesis treats them separately. This provides a much wider view, as is shown in the Analysis section. Additionally, IS deployment in Libyan oil companies was assessed by using similar methods to those of [23]. All of these studies investigated IS deployment from a managerial or strategical perspective, unlike this study, whose aim was to assess universities' readiness for building their own systems and assess the appropriateness of the CD-ERP model as a solution. Indeed, these studies neither discussed the development of ISs in Libyan universities as a whole nor suggested any solutions. In contrast, this study proposes a solution to the issue of developing ISs by introducing the community-source approach as represented by the CD-ERP model.

Additionally, the CD-ERP model presented here follows the principle of community-source in a similar way to other projects. However, our model differs, since it is based on ERP. Indeed, all of the above-mentioned projects built integrated ISs based on existing codes/systems, e.g., the HisinOne project [21]. Additionally, the authors found that the level of ISs in Libyan universities is very low, there is a lack of capabilities for IS development, and difficulties exist in integrating certain projects (for example, Sakai) with other enterprise software systems, such as ERP [24]. Hence, the CD-ERP model is based on ERP in order to avoid building integrated ISs from scratch and achieve faster and more reliable results.

4. Analysis of the Level of Information Systems in Libyan Higher Education

This section briefly discusses these results, since a full description is impossible within the confines of an article. The focus in this paper is mainly on the management of the information flow between universities during student exchange and provides examples of processes that facilitate education and the merits of the CD-ERP approach.

Basically, this research is an introductory study to investigate the applicability of a community-source approach in LHE that was constructed on the basis of an ERP system. In order to build the proposed system, three main data resources were selected, namely (1) a review of the relevant literature to understand the critical factors for the successful adoption of this model in which the following topics were covered: IS development with an emphasis on collaboratively-developed ISs, ERP systems, multi-tenancy, and cloud computing; (2) lessons learnt from international experiences, based on a number of selected cases; and, most-importantly, (3) findings from the fieldwork in Libya in which three Libyan public universities were surveyed. A review of international collaborations for the development of ISs in higher education and a discussion of the critical success factors in such projects can be found in [25]. A description of the formal study and its empirical findings can be found in [26].

The authors noticed that all three cases shared common characteristics, as well as differences, in terms of the status of IS deployment, which can be summarized as follows: Generally, the level of technology in Libya is low, which should be considered before adopting advanced systems. Though all the respondents from the three universities agreed on the low level of ICT in general and of the ISs deployed in particular, some points were mentioned as strengths on the basis of the current status.

In all three universities, there is an office that is responsible for handling information technology and communication issues. The structures of these offices are also similar. In all three universities, there are three main categories of ISs implemented for each type of business process, as itemized below.

- In-house applications: These have been developed locally by Information Technology (IT) teams by using a variety of technologies and platforms. This makes it impossible to integrate them into a single connected architecture. All of these applications are out-of-date, not well-documented, and possess many negative features.
- Applications purchased from local vendors, which most often are maintained by the vendor itself. In some cases, these are open-source applications that can be modified by the local IT team. However, these applications are not easy to maintain or develop. These applications are even more difficult to integrate, since some of them are not editable.
- Standalone office automation packages (MS Excel/Access) are used to support most activities in all three universities. In some cases, these packages are used alongside ISs. However, the integration of these systems is limited to manual communication. There is no bridging software. Data are transferred in formats such as Excel, CSV, and database files, and they are even manually re-entered in some cases. This kind of data transfer can be risky and requires technical skills.

Though top management appears to be dissatisfied with the existing ISs, they are not ready to invest more in IT. Top management is convinced that most business and sub-business activities need applications based on the latest technology but is worried about the consequent costs. There has been a noticeable improvement in the reliability of the information that is gathered in business activities due to the use of ISs, which is reflected in better decision making. However, this improvement is limited, since the reports that are generated from the deployed ISs are not available instantly, as required by top management. The majority of data are transferred in paper format or by conversion into other files, such as MS Excel or Access. More specialist staff are required. However, due to pay differentials, it is difficult to find such experts. In fact, the current development teams are unable to trouble-shoot some of the systems currently running, which is reflected in the limited benefits that are expected from these systems.

The future development of an integrated IS should take the strengths and weaknesses of the involved institutions into account. With regard to teaching activities, none of the three studied universities have an integrated system supporting their educational activities across all the faculties. The UOT has the most advanced IS in this field, since it is the only studied university that deploys both offline and online versions of ISs for educational activities. With regard to e-learning systems, the UOT used to run such a program, while SU and MU have never implemented such a system. The UOT program was terminated due to current political instability. The issue of duplicated ISs is seen in the UOT and MU, especially in the implementation of educational activities, while it is not visible in SU. However, some of the ISs that are used in the UOT for course management were developed in-house. This indicates that the UOT has the potential to take an active part in the development of an integrated system that supports teaching activities. Additionally, it was stated during the interviews at the UOT that Al-Mergib University and Bani Waleed University had recently adopted the student management IS that was developed by the UOT. The contract includes training IT staff in these two universities to use the source code, e.g., to troubleshoot the system. This indicates that there is cooperation between Libyan universities and expertise is being developed.

With regard to supporting research activities, although there are some ISs being implemented, none of the universities have an integrated system. Again, the UOT has implemented a higher level of

technology than MU and SU in this category. Systems that facilitate administrative activities include human resource information systems (HRISs), finance and accounting ISs, and administrative ISs. MU is considered to be the first Libyan university to use a HRIS for both academic and administrative staff. This was developed in-house by using a Delphi/Structured Query Language (SQL) database. Overall, MU has implemented the most advanced ISs in this field and shows the potential to play a role in the development of an integrated system. The UOT does not possess any HRISs, except for the administration of academic staff, while finance and accounting are partially computerized. Unlike the UOT and MU, SU lacks any IS to handle administrative activities.

Importantly, all three universities have ISs that are provided by the Libyan Ministry of Education. For instance, there is an IS for students who have been awarded a scholarship to study in another country. Hence, despite the weaknesses that are apparent in each university, there should be clear gains from the pooling of the available expertise within universities and the Ministry of Education. However, this expertise is not sufficient on its own to develop and implement an integrated system at the national level. For these reasons, it is suggested that a nationally integrated system should be founded on a solid base. Such a base could be provided by an ERP system that is flexible enough to be adapted to the needs of higher education. This approach is outlined in the following section.

5. CD-ERP Approach

Based on these observations, the collaboratively-developed enterprise resource planning [CD-ERP] approach was proposed. CD-ERP is a model of software development that is intermediate between two well-known models (closed- and open-source systems) where both administration and development costs are shared among the beneficiaries (here, Libyan universities under the direction of the Libyan Ministry of Higher Education). The CD-ERP model is a comprehensive and secure version of cloud-based ERP that is jointly developed (or at least the development is jointly guided) by educational institutes. Such a system would provide access to current information to all the stakeholders via a range of devices. The administration and development costs are determined in the form of an agreement, where rights and duties are also defined. This model is aimed at both LHE institutes and the planners of LHE at the Ministry of Education. The adoption of such cloud-based ERP solutions is projected to integrate the business activities of universities via a single information system, as shown in Figure 2. Based on the model of business activities in HE institutes that was presented in [27], the business activities in HE institutes are divided into educational, research and other activities. This ensures that different types of institutes can join the consortium, regardless of their type and size. For instance, research institutes can benefit from ISs that are dedicated to research activities or ISs that are devoted to other (administrative) activities.

A nationally integrated system that adopts this concept would be based on modules that support specifically defined processes. Three such processes that facilitate student education are considered in the following section.

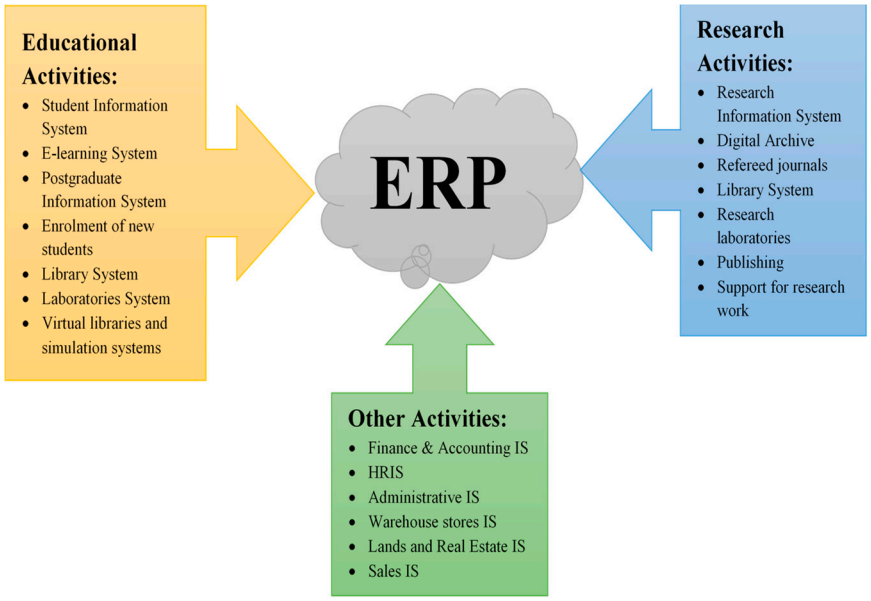

Figure 2. Cloud enterprise resource planning (ERP) for higher education (HE) institutes. This is the authors' own work, and the activities are classified on the basis of the model of business activities in HE institutes that was presented by [4].

6. Examples of Processes Facilitating Education and Merits of the CD-ERP Approach

Nowadays, universities are constantly striving to internationalize studies via student exchange programs, such as Erasmus. They are also constantly increasing the number of foreign academic staff and thus adapting themselves to the needs of the changing labor market. The development of contacts between the business world and universities, e.g., organizing foreign internships and apprenticeships for students, is also very important. Modern technologies are increasingly becoming an integral part of everyday life and should be widely included in the education process as well. The CD-ERP approach is an innovative concept that can improve the flow of information between cooperating universities. The authors chose three specific business processes and created maps of them (based on interviews that were aimed at elucidating how they are run in the 'real world of higher education'). These maps are illustrated in Figures 3–5. All of these examples are related to cooperation between two (or more) universities in the education process. The following processes that facilitate the exchange of a student between his/her "alma mater" and a hosting university were taken into consideration:

- The procedure for extending a student's stay at the hosting university (from the point of view of the alma mater).
- The procedure for extending the stay of a student from point of view of the host university.
- The procedure for returning to the alma mater.

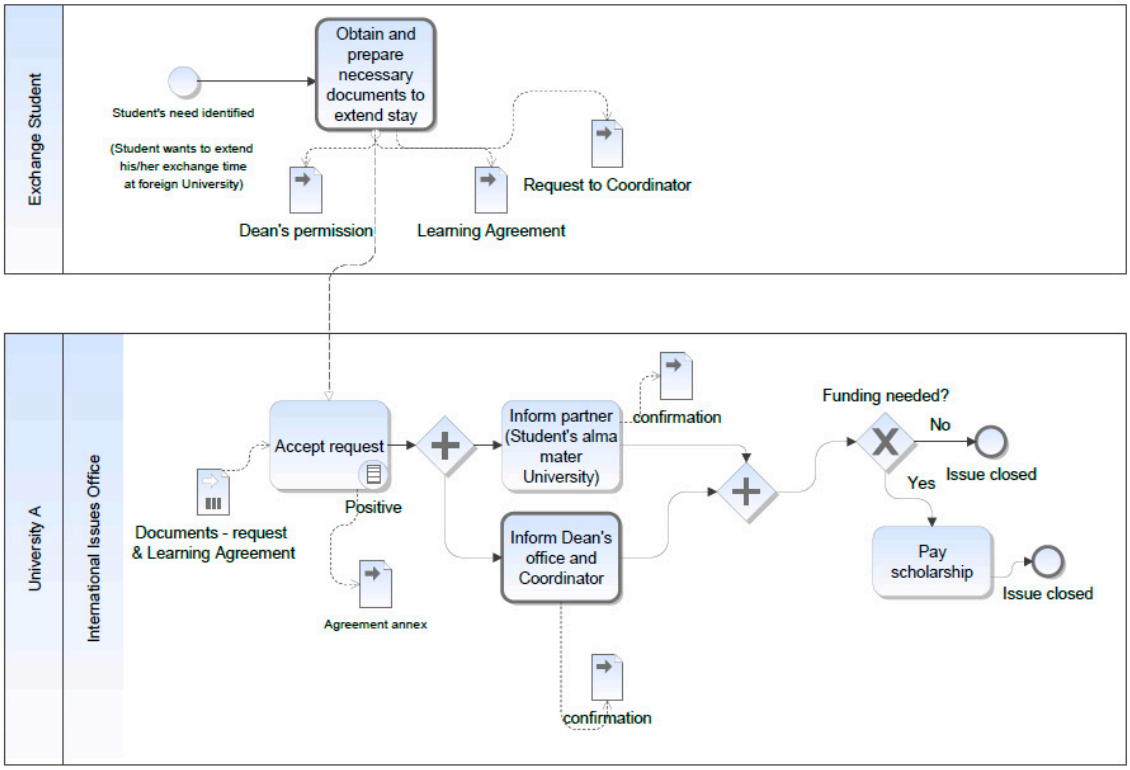

Figure 3. Map of the procedure for extending an exchange student's stay at a foreign university.

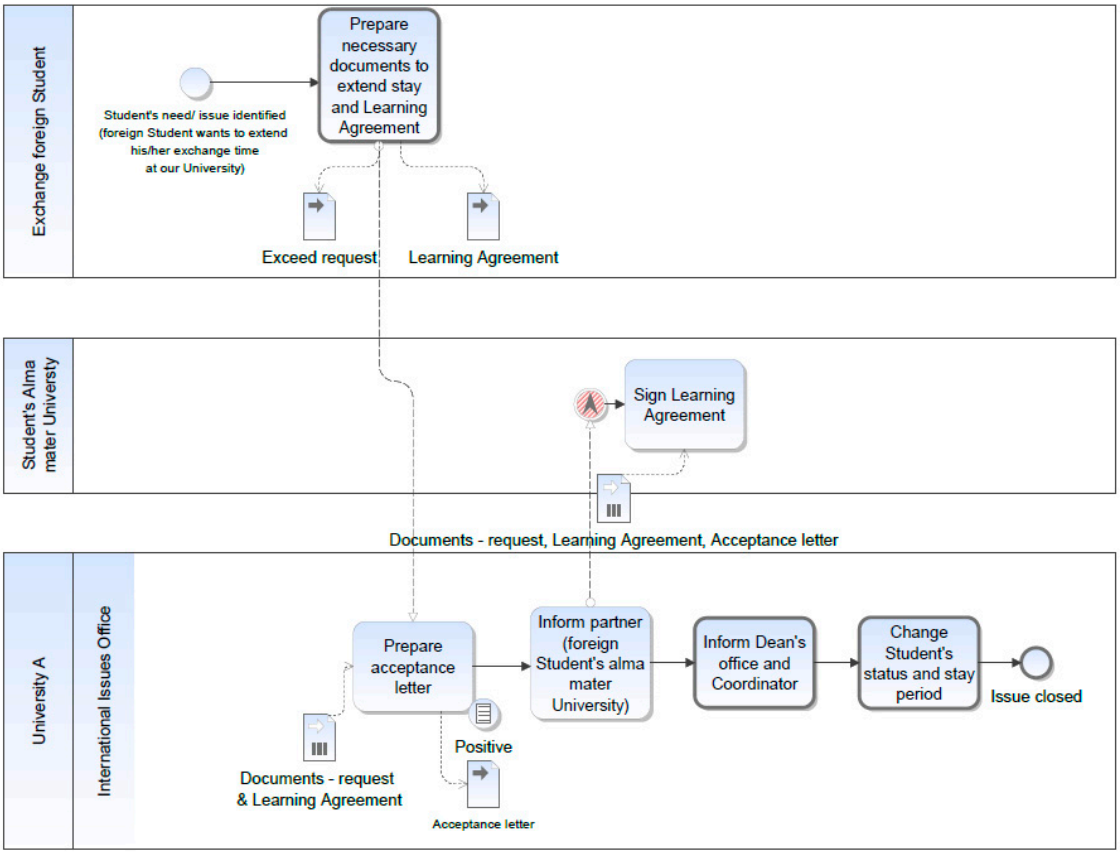

Figure 4. Map of the procedure for extending the stay of a foreign student at a Libyan University.

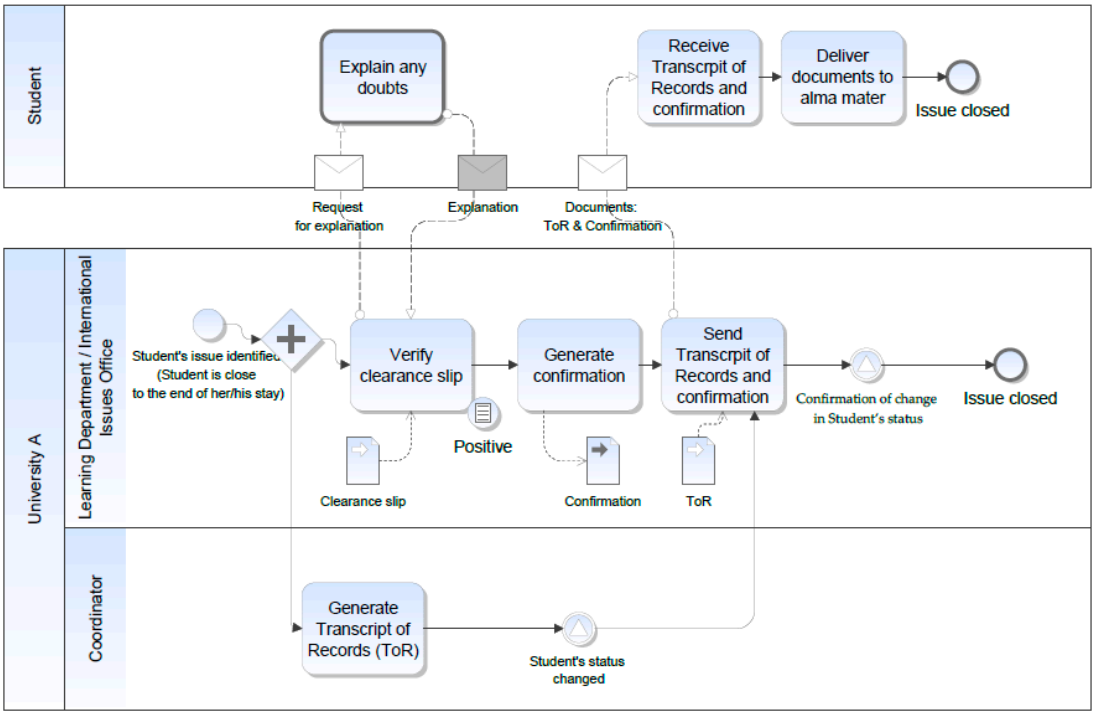

Figure 5. Map of the procedure of a student returning to his/her alma mater.

A description of the benefits and weaknesses of the CD-ERP approach were described in [25]. The adoption of a nationwide system has clear advantages in sharing the costs of system development and facilitating the exchange of information between universities. On the other hand, the weaknesses of the CD-ERP approach are often related to managing the changes in work processes that are required. Universities may have different procedures for managing the programs that their students follow, and these procedures must be unified in order to implement a nationwide system. Another issue occurs when we consider the possibility of students studying in other countries. The system that is adopted in Libyan HE should be flexible enough to allow for communication between different ISs.

It should be noted that accurate and punctual information is required in all the processes described above. This is particularly the case regarding the learning agreement to be made before a student's continued course of study at a hosting university. The implementation of the CD-ERP concept would enable educational institutions to collect all the necessary data by using standardized electronic documentation and thus avoid any redundancy. All of these features can be very helpful, both at the beginning of the whole procedure—especially in student evaluation—and when a student ends or wishes to extend his/her stay at the hosting university. The possibility of storing all of the relevant data in a single database allows the involved organizations to instantly exchange and check electronic information. This eliminates the need for paper documentation. A CD-ERP approach would aid cooperation between universities and control all the necessary resources that are required to enable the exchange of students. All changes are immediately visible to the relevant users, so each user can formulate a query to generate the required reports, and we can be sure that the same version of the database is used. Last but not least, communication procedures can be improved. Every single entity who participates in such procedures can follow the flow of documents and inform business partners if there is any inconsistency. In this way, the successful adoption of the CD-ERP approach guarantees better cooperation, data integration, and the management of information.

7. Conclusions

The authors analyzed findings from fieldwork that was carried out in three Libyan universities on the level of the implemented ISs by using selected techniques. This analysis enabled a comparison of

the current level of the ISs that are deployed in these three institutions. Such an analysis was used to determine where opportunities exist to develop a nationally integrated system. While the overall level of the ISs deployed in Libyan universities is low, there are several strengths that can be employed in developing an integrated system. In particular, the Ministry of Education and the UOT have expertise in developing ISs to facilitate student education, and MU has expertise in developing ISs to facilitate their administrative procedures. In addition, the UOT has cooperated with other universities by supplying them with a student management IS, and it possesses experience in training personnel to maintain such a system. No university on its own has the potential to develop a completely integrated system. However, pooling this expertise and applying a sufficiently flexible ERP system would enable the development of an integrated system that uses the CD-ERP approach.

The implementation of such a nationally integrated system would require a large number of modules, each facilitating a well-defined process. This article considered three such processes that are related to the transfer of students between universities. The implementation of the concept of CD-ERP to create an integrated system would give great advantages in the management of such activities, due to the participating universities having instant access to a single electronic database.

This research is an introductory study, and its scope is very general. It is recommended that a research team is set up to carry out comprehensive interdisciplinary examinations and run more case studies on Libyan universities and community colleges, in both the public and private sectors. These studies should investigate topics such as the cooperation between academia and industry in a community-source environment and the applicability of Agile practices (Agile is an adaptive model of system development) in the context of a community-source environment. International experiences should be also studied using a multidimensional research instrument to measure service quality [28–32]. Besides, it is recommended to conduct a comprehensive study that uses tools for strategic analysis, such as SOAR (strengths, opportunities, aspirations, and results), noise analysis, and PESTLE (political, economic, sociological, technological, legal and environmental) analysis, to make a systematic and thorough evaluation of the CD-ERP model [33,34]. Eventually, it is planned to develop a prototype system that is based on the CD-ERP model in order to assess the applicability of this approach in practice. Since this is an ambitious goal in itself, it is left for future research.

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