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Enterprise Resource Planning Systems Development in Omani Higher Education Institutions from the Perspectives of Software Project Managers and Developers

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Abstract Enterprise Resource Planning (ERP) systems have recently gained significance among companies, organizations, higher education institutions, and business owners in Oman. Delving into the implementation and success of ERP systems is a time-consuming process and mostly requires longitudinal research. In line with the significance of such systems, we conducted a qualitative study to understand the practices involved in developing ERP systems from the perspectives of the software project managers and developers. In doing so, we interviewed a software project management and development team. The interview included both structured and semi-structured questions. We focused on three factors, including a) the software project managers' and developers' viewpoints about the ERP systems development in the HEIs, b) the methods and processes followed by the team while developing ERP systems for the HEIs, and c) the technical and non-technical challenges encountered within the development, implementation, and deployment stages.

Keywords: *Critical success factors, Enterprise resource planning, Higher education institutions, Software development, Software requirements*

1. Introduction

Enterprise Resource Planning (ERP) systems are business management systems designed to integrate and manage all business processes involved in an organization. This is accomplished using a set of software that addresses a variety of corporate functions, including financial and accounting management, human resource management, and transport management, to mention but a few. Implementing the ERP systems in the context of Higher Education Institutions (HEIs) has recently gained significance among researchers (Abugabah & Sanzogni, 2010). To date, colleges and universities have implemented various types of ERP software such as ITG, Banner, PROMIS, LOGSIS, Classe 365, E-Register system, SITS-Vision, IFW Campus ERP, Microsoft Dynamics, KSoft College Management System, and Oracle Student Cloud. The US universities are using ERP systems from vendors such as PeopleSoft, Banner, Jenzabar, Datatel, and Campus Management (Abdellatif, 2014). A quick search of the

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literature reveals that the theoretical studies on ERP systems have nearly saturation. Researchers have recently shifted their focus toward implementing these systems (Haddara & Zach, 2011; Schlichter & Kraemmergaard, 2010).

An ERP system within the context of an HEI helps manage various processes, including student registration, fees, library, student grades, courses, timetabling, and issues related to its staff. Automation leads to transparency, efficiency, and productivity. Higher education in Oman has recently seen a significant transition in academic and quality standards. The real-time data accessibility is challenging, another challenge in Oman's higher education sector. For instance, having timeliness of various procedures such as class tests, timetabling, teaching, registration, and real-time response flexibility is necessary. An ERP system may help the HEIs overcome many obstacles by connecting all their units, departments, and sub-systems into a single database that functions as a fully integrated system.

In the sultanate of Oman, the ERP systems implementation is relatively new, especially in the higher education context. Many HEIs in Oman confront ERP development-related issues due to various factors, including integration across multiple units, incomplete requirements, expertise, etc., which could lead to inconsistency and quality comprise. Although the general deployment of ERP systems in various contexts in Oman has been more or less explored by researchers in many sectors, to date, no single study has been conducted to delve into the implementation of ERP systems from the perspectives of software developers and project managers in the context of Omani HEIs (Al-Hinai et al., 2013; Al Mahrami & Hakro, 2018; Al-Sawa'ei et al., 2015; Maguire et al., 2010). In line with this significance, the present study aimed to answer the following research questions:

1- What are the software project managers' and developers' viewpoints about the ERP systems development in the HEIs?
2- What methods and processes do software project managers and developers usually follow in the ERP system developments for the HEIs?
3- What are the technical and non-technical challenges software project managers and developers encounter within the development, implementation, and deployment stages of ERP systems for the HEIs?

2. Theoretical Framework

A literature review by Haddara and Zach (2011) revealed that the focus of ERP systems has recently shifted from large to Small and Medium Enterprises (SMEs). The implementation of ERP systems has improved with the recent advancements in technology. In a systematic literature review (Abd Elmonem et al., 2016), the benefits and challenges of ERP system implementation using cloud technology were discussed. The findings indicated that despite several challenges and difficulties of cloud ERP systems, they offer significant advantages and benefits to their users. ERP system helps higher education use the data related to students, faculty, and administrative staff more organized and structured (Rabaa'i et al., 2009). The organized data results in real-time analytics. Teaching staff, non-teaching staff, and students can have a voice and talk with one another in ERP. The tests, assignments, and grades can be easily communicated (Ahmed & Ayman, 2011). An ERP system allows the storage of a large amount of organizational data. The analysis of stored data helps the management with real-time accurate and balanced decision-making.

There are two kinds of ERP systems implemented: cloud-based ERP and traditional or on-premise ERP. On-premise ERP is installed on a local server or host computer and managed by the IT staff of the HEI. The commercial vendors developed and managed commercial off-the-shelf (COTS) ERP or cloud-based education ERP system solutions (AlQashami & Heba, 2015). No local IT staff is required to look after it. Implementing an on-premise ERP system is less efficient than cloud-based ERP systems. The cloud-based ERP is faster in implementation and more secured than on-premise. According to Koch et al. (2012), an ERP system is implemented in three ways. These are a) Big Bang – the organization replaces the existing system entirely at once with an ERP system, b) Franchising – the organization

executes customization of some units where similar processes are interconnected, and c) Slam-Dunk method –the organization replaces some key processes, such as financial processes.

2.1. Selected ERP Systems at HEIs

Noaman and Ahmed (2015) conducted a comparative study on ERP systems in GCC and found that SAP, Oracle, PeopleSoft, and JD Edwards were rarely used in higher education. In Saudi Arabia, some universities have been utilizing various ERP systems successfully (Abdel-Haq, 2020). These include King Abdul Aziz University (ODES plus), King Saud University (MADAR), King Fahd University (Moraslat), in addition to Al-jouf University, Hail University, King Abdullah University, King Saud Bin Abdulaziz University, Taibah University, Islamic University, King Faisal University, and Shaqra University (Aldayel et al., 2011).

The SAP, Baan, and PeopleSoft ERP vendors have attracted Brazilian and Mexican institutions (Abdellatif, 2014). According to Khand and Kalhoro (2020), the Higher Education Commission (HEC) of Pakistan funded ERP system implementation in eight selected universities to understand the ERP system's benefits.

Ellucian Banner (formerly SCT Banner e-Education from SunGard): It can handle campus-wide needs such as student management, school financials such as tuition billing, administrative staff management, and the allocation of financial aid. Over 2500 HEIs use the software globally (Ellucian, 2021).

Oracle Student Cloud: It offers complete cloud-based services. The essential features of Oracle Student Cloud include financial planning, recruiting, and an entire student information system (Oracle, 2021). The solution from Oracle is very comprehensive and directed toward HEIs. The focus is on adaptability, innovation, and insight (Abdellatif, 2014). The King Fahd University of Petroleum and Minerals has been using Oracle ERP since 2006. The objective was to improve, enable, and integrate academic and administrative activities (Althonayan, 2013). Finally, it allows fast and accurate decision-making using relevant stakeholders' real-time data. King Faisal University has also implemented the Oracle system since 2008. The purpose was to improve academic processes, administrative processes, decision-making, human resource capabilities, accountability, and accessibility of relevant information (Althonayan, 2013).

Academia: It covers both administrative and student processes. There are student and parent portals as well as a mobile application. The software is widely used in universities, colleges, and K-12 institutions Academia: This is an open-source system with 200 educational institutes from India contributing to and/or using it. It is a scalable software that uses Java technology.

IFW Campus ERP: For the last 14 years, this software has provided services to educational institutions. It covers university management, administration, and finance. Its features include academics (admissions, alumni, assignments, blog, news, downloads, e-newsletter, distance learning, events and conference, exam and results, hostel, library, mentorship, notes, online exam, student registration, student attendance, syllabus and lesson plan, timetabling, transport, and e-library), administration (dashboards, employee attendance, feedback on faculty, front office, photo and video gallery, general feedback, grievance, employee registration, lost and found, media, polls), and finance (accounts, fee, stock, shop, payroll) solutions.

SAP: Bologa and Lupu (2014) showed how SAP could be used in HEIs. The modules she studied were student life cycle management, business service, grants management, governance and compliance, procurement, enterprise asset management, human capital management, performance management, financial management, and relationship management (Bologa & Lupu, 2014). In 2005, Purdue University started implementing SAP as well. The finance, Human Resources (HR), and student administration modules were implemented in the beginning (Qian et al., 2015).

College Management System: KSoft owns College Management System ERP. The system manages the educational institution, students, departments, staff, and other features. It is easy to customize the software as per needs. The main features of this system include attendance, student transportation monitoring, exam management, SMS, fee management, staff management, dashboards, front office

tools, room and board fee management, department tracking, library management, user control, time, and schedules (Ksoft, 2021).

Einstein: It is a cloud-based student information system. It was developed by Orbund. The main features of this system are the application portal (application fees, credit card processing, website integration, and direct application system), administration portal (student management, alumni management, contact management, class scheduling, invoice and payment process, custom reporting tools, clock hour program, credit-based programs, financial aid, award letters, and integration with QuickBooks), instructor portal (online tests, online course material, incident, and issue tracker, online assignment, class announcements, support learning tools, framework, online course videos, attendance and grades post, schedule, progress report, and library and equipment reserve), student portal (access class communications, online academic reports, online tests, assignment submission, incident and issue tracker, schedule, progress report, library, and equipment reserve (Orbund, 2021).

Mentis: This ERP system is developed by Inknowledge, a Brainvire product. The purpose is to automate educational processes. The main features are research, teaching, service portfolio, grant management, student mentorship, e-learning compliance, conflict of interest management, dashboard to-dos, updated reports and analytics, and customizable workflows (Inknowledge, 2021).

MADAR: It is used by King Saud University in Saudi Arabia for administrative purposes (Al-Shamlan & Al-Mudimigh, 2011). This system is used explicitly for administration communication, warehousing, warehousing surveillance, finance, purchase, human resources, and budget.

BINUS Campus Solution (BCS): This solution is implemented at BINUS University, Indonesia. It is an on-premise ERP system. The implementation and use are influenced by budget and project management, training, and user satisfaction (Widjaja et al., 2018).

2.2. ERP Success Factors and Oman

An empirical study on the ERP system implementation within higher education was conducted by Al-Hadi and Al-Shaibany (2017). The study focused on distinguishing the Critical Success Factors (CSFs) while implementing such systems. According to the researchers, these CSFs were a) transparent vision and objectives, b) support and commitment from the management, c) transparent organizational structure, business process, and information flow, d) budget size and cost, and e) tackling the issues related to human resources, f) project management, training, and education, g) careful change management, and h) effective connection and communication.

Kalema et al. (2014) aimed to identify the CSFs of ERP system implementations in higher education contexts. In this regard, the researchers came up with 37 ERP CSFs in the context of higher education. In the ERP investigations, the context of higher education has widely been neglected by researchers worldwide (Abugabah & Sanzogni, 2010). This applies to Oman's higher education context, as a literature search revealed no particular studies in this context. However, few studies have been conducted in Oman regarding ERP systems implementation, yet not in HEIs.

Al-Hinai et al. (2013) surveyed Omani organizations to determine whether the importance level related to each CSF would vary during the ERP implementation life cycle. The CSFs they assessed were extracted from the body of literature. The findings indicated that the CSFs would change in terms of importance, and as the implementation of the ERP goes on, the number of CSFs that are more significant increases. In addition, it was indicated that different categories of CSFs varied in terms of importance across the ERP implementation life-cycle.

Jafari and Nair (2018) conducted a mixed-methods study to investigate the efficiency and ERP systems among Oman's oil and gas companies. The research was a combination of survey analysis and literature review. The findings suggested that Oman's oil and gas companies should implement ERP systems to boost their growth from different perspectives.

Al-Sawa'ei et al. (2015) conducted a case study on the rationale behind implementing ERP systems in Oman. In addition, the study was an attempt to come up with the critical benefits of investments in ERP. The researchers reported several factors to motivate Oman-based organizations to adopt ERP systems. Some examples were the need to integrate multiple existing systems into a unified one, the need for real-time information, and market competitiveness.

Through a case study, Maguire et al. (2010) studied the perceptions of ERP system development in Omantel, the leading telecommunication company in Oman. The study discussed some of the significant issues large companies face while implementing ERP systems. Maguire et al. (2010) came up with seven main themes, namely, a) stakeholder consultation, b) vendor selection, c) project management, d) stakeholder management and communication, e) training, f) risk management, and g) system re-engineering and software customization. These findings were then mapped against the existing literature to distinguish the critical environmental factors that have affected the implementation of the ERP system in Omantel.

3. Methodology

The present study used articles, book chapters, and conference proceedings from reputable indexing/abstracting databases (Elsevier's Scopus, IEEE, Web of Science) to develop the research questions and objectives. In line with the significance of the ERP systems, we conducted a qualitative study to understand the ERP systems development practices from the perspectives of software project managers and developers. We invited the software project managers and developers team working with an Omani private HEI to participate in the interviews and express their opinions based on structured and semi-structured questions. Data collection lasted two months. The participants (6 male individuals aged 30 to 40) were briefed on the research purpose and scope before the interviews.

4. Results

The ERP project started at the HEI in April 2019 and was ongoing by the time this research was conducted. The respondents were asked about their years of experience in educational ERP systems development. The average experience was above five years. When enquired about whether they found the ERP development requirements clear from the very beginning stages of the project implementation, it was stated that:

> The requirements of the HEI were not precise because of the departments working independently. The legacy system was also not integrated with other departments, and data were not fully available in the legacy system. Most of the data were maintained manually. We did multiple iterations to collect the final requirements. We faced communication issues with departmental users to get the process flow and integration with finance and other standard modules. We resolved by following our implementation approach.

To a question about whether the requirement elicitation techniques were adequate, the reply was:

> We approached the existing software technician to identify the master data and transfer them to the Axpert CMS ERP system. We also approached individual departments and entities to get the master data. We approached the legacy system admin to retrieve the data, but the provided or available in the legacy system was inappropriate.

The development team used a ready-made model ERP system based on specific industrial standards. They did not develop the ERP system from scratch; it was rather ready-made and customized based on the needs and requirements of the HEI.

> We collected requirements from each department and customized them accordingly. Each educational institute has a different mechanism to follow to meet the affiliated university's standards. Depending on management policies, the ERP system needs to be customized differently.

Further, it was asked about the process and techniques used to gather the requirements and development. The response was:

> We are using Agile technology as the implementation methodology. A gap analysis was done through a Conference-Room Pilot (CRP1) presentation followed by a review. The User Acceptance Testing (UAT), Transition and Cut-over, and system stabilization were also employed.

On asking about the type of management support the development team received from the HEI, the reply was:

> Yes, we got appropriate support from top management. The top management was familiar with the benefits of an ERP system. For instance, all departments can share common data, no duplication of work, etc. The top management was willing to spend money on the ERP system development. However, a couple of new requests during the development required an additional budget.

The development company followed a multi-tier approach to the project management, execution, and delivery of the project.

> The Company follows the multi-tier approach to project management to make every project successful in achieving the project objectives. Project organization is created with clear lines of communication during the project implementation. The implementation team comprises a project manager, consultants, and testers. The company's implementation team will interact with the process owners of the customer organization for free flow of information on processes, practices, and requirements.
>
> The Company's Project Manager operates in concurrence with the single point of contact from the customer organization. They coordinate the necessary meetings for requirement gathering, project reviews, and clarification sessions. At the next level, the company's management team and the customer organization's management team will constantly touch each other during the project implementation to ensure faster resolution of any conflicts.

The team was enquired about IT Infrastructure and whether it was sufficient to support the implementation of the ERP system.

> IT infrastructure in Oman is sufficient for ERP system implementation; however, the HEI has to buy an Oracle license for the ERP system because the existing Oracle license was expired. Automated attendance requires attendance devices and library management equipment to be procured.

The Quality Assurance and Control (QA & QC) were followed. The Company used the process of user-testing for all modules, such as agreeing to a cut-off timeline with the business team and planning the activities for production setup covering functional and technical design, data migration, and user access rights definition.

> The acceptance criteria would be a pass in the test cases for developed units and configured applications (including all processes, setup data, opening balance data, etc., if any and as applicable). This means that as soon as the test cases provided by the customer pass, the corresponding units, products, or functionality is considered accepted.

The Company conducted the user-testing as well with some challenges:

> Because of multiple iterations, we conducted numerous user tests. This created a delay in the project timeline due to the non-availability of users as they were occupied with their regular tasks.

Besides, the Company added certain checks:

> The HEI needs to perform UAT within a stipulated and agreed timeframe. The deliverables are accepted if the testing results are not provided within the agreed timeframe. During the UAT phase of the project, all issues will be collated. Successful resolution of these issues will be considered an acceptance of the Solution.

Concerning the training on the new system, training methods, and the participants, the reply was:

> We provide a training session to all key users of the HEI at a central location. It would be the responsibility of the HEI to bring all the key users [including all locations key users and all collection center key users] under one roof for the training. Any additional end-user training shall be handled by the customer's key users, such as end-user training, critical user training, and training the trainer.

The Company claimed that the developed HEI ERP system follows the proper security measures to ensure its users' data privacy and integrity.

> The proposed system is embedded with good security and access rights control standards, which provide the capability to adapt information security and integrity. The system has built-in data security at all levels to give you absolute peace of mind. Getting new reports or making changes to existing processes is hassle-free and can be managed by in-house power users. Any process change is simple and quick, costing the least in terms of both time and money.

5. Discussion

ERP systems have recently been utilized in Oman to resource development and appropriate decision-making; however, data accuracy, user-friendliness, broad accessibility, security, and consolidation of the systems into one database need attention. Developing an on-premise or custom ERP system for an institution is beneficial for customization, time, and cost.

The core ERP modules are student information, human resources, and finance (Chaushi et al., 2018). The student information module in an ERP system manages student processes and stores their details. For instance, a student can register for classes, seek assistance, manage grades, track attendance, and generate reports. The human resources module contains the teaching and non-teaching staff. The main features are handling new recruitments, tracking tenures, processing payrolls, and viewing timesheets, leave requests, and compensations. The finance module is used to manage the accounting and finance of an institution. It includes tuition and fee management, budgeting, accounts payable, accounts receivable, reporting, procurement and requisitions, and grant certification.

Nah and Delgado (2006) noticed that the success of an ERP system depends on (1) a business plan and vision, (2) change management, (3) communication, (4) ERP team composition, skills, and compensation, (5) project management, (6) top management support and championship, and (7) system analysis, selection, and technical implementation. In a case study conducted in higher education in the UK, Allen et al. (2002) found CSFs of ERP as need of the system, top management support, project schedule, communication with stakeholders, technology, technical and business skills, user acceptance, review, and feedback from stakeholders.

Thus, successful implementation and deployment of ERP systems need to define the educational institution's goals and requirements. The goal and requirements should be described in detail for the development team. All the stakeholders in the institution should be consulted about their problems, suggestions, and expectations. They should be asked which part of the system they are interested in getting automated, whether student management, HR, finance, etc. An exploratory study by Shatat (2015) aimed to determine the most critical CSFs during ERP implementation in organizations based in the Sultanate of Oman. Findings of the study revealed that 10 of the CSFs were the most significant ones. These included a) monitoring and evaluation of performance, b) project champion, c) top management support, d) clear goals and objectives, e) user involvement, f) strategic IT planning, g) user training and education, h) teamwork and composition, i) vendor support and j) education on new

business processes. Somers et al. (2003) conducted a study in the USA. They concluded that management support, project team competence, inter-departmental cooperation, clear goals and objectives, and project management were the most critical factors for the success of an ERP system.

The next step is to start a user-friendly, simple, and straightforward UX/UI design. Using the wireframes tool helps in executing the UX/UI plan successfully. Developing an ERP system often needs the integration of third-party services, for example, G Suite, Office 365, Fresh Books, Jira, Salesforce, and SAP. The software developers access the data and displays in the ERP system with the help of APIs from third-party services.

Several QA engineers should test each module. The developers should fix the bugs found. Moreover, the stakeholders in the ERP system can act as beta-testers. A study conducted in Saudi Arabia (Abugabah et al., 2015) looked into the impact of ERP systems in higher education. According to the findings, information quality, system quality, and task technology fit were the most significant factors leading to better end-user performance. Al Mahrami and Hakro (2018) aimed to explore the ERP features, efficiency, and implementation in selected organizations based in Oman. These factors were assessed through an online questionnaire and a survey distributed to both governmental and private organizations. The findings highlighted the potential ability of ERP systems to reduce the cost and time in operations while supporting the managerial work for making better decisions. Accordingly, these led to increased service efficiency and the system's reputation with the ability to save all the employees' information safely. According to Chatfield (2005), ERP systems require user training and management support. Seo (2013) reported change management, communication, planning, ERP systems integration, and top management support as CSFs of ERP systems.

All in all, ERP systems are used in various contexts, and the emerging area is HEIs. This has urged the researchers to conduct qualitative research. While developing the ERP systems, multiple factors must be studied. Based on the findings of the present work, some examples may include the planning, design, implementation, user performance, and user experience of the ERP systems. The results also revealed a lack of concrete studies on different aspects of the ERP in the higher education context. Although some researchers have already conducted research focusing on this area, it is still in its infancy. Based on the findings, no single study has been undertaken in Omani HEIs. Therefore, it is suggested as an entire research area, urging further research.

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