Óbuda University

PhD Thesis Summary

Doctoral School of Applied Informatics and Applied Mathematics

Enhancement of business information systems for small and medium sized enterprises, while transferring the business processes and services into computational cloud.

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Contents

Background of the Research

As cloud-based technologies are evolving and takes place in everyday IT technology, it is obvious that Enterprise Resource Planning (ERP) systems are compelled to keep up with the changes. Cloud based information technology has created a need for a new software abstraction layer above the traditional implementation layers, and therefore fundamentally changed the way how Enterprise Resource Planning (ERP) systems are implemented and developed over the various hardware and software abstraction layers. The complex part of the changes is that ERP systems mirror the end-to-end business processes of an organization. This research focuses on the small and middle size enterprises (SME) in the area, considering the fact that SME's resources are often more limited, emphasizing the importance of code reuse and refactor. As these organizational processes and the company objectives, goals commonly form the information system (IS) management, it forms a complex task for business process reengineering (BPR).

I introduced a new method for identifying the code parts which can be reused during the uplift process. I also made a proof of concept for validating the new process, and demonstrated its results. I managed to prove the new process in real life projects, which is demonstrated in my thesis, expect parts which are under live intellectual property coverage.

In the next chapters I follow up my new method during the BPR process, which is a complex one, as customer needs, company goals and even already existing proceedings must be aligned together, which often difficult to reconcile. The thesis also explores the shift from traditional waterfall project management methodology towards agile methodologies. The main difference lies in moving away from the waterfall model which is based on a static type software development progress a towards an evergreen agile solution [20]. This needs a change in the attitude on the project management and software development side also: instead of searching for and trying to reach the always 100% flawless solution, this method tries to iterate towards a continuous improvement for the project and the end product.

Previous lifecycle management processes from the assessment phase unto the post go-live and business as usual support phase handled the business logic as one common entity with its implementation. Which practically means, that the question of code reusability has now a new role as in the well-known on-premise model. I have introduced a new method of identifying and encapsulating those software parts, which later can be reused in a cloud SaaS environment. As the SaaS model has brought a new abstraction layer into the operation model of cloud-based software, the question of refactoring becomes more important, because the core business logic remains the same (or very similar).

This thesis introduces a change management methodology demonstrated through a specific ERP system, cloud-based Microsoft Dynamics 365 Finance and Operations, from the viewpoint of business process lifecycle maintenance implementation project. This implementation process is suitable for supporting long term maintenance and the evergreen property of the software product. This schema can result in longer lifetime for the software product, as it can be fully segregated from the constantly changing physical implementation layer. As the constant implementation of new technologies is present in the recent IT architecture, the introduction of this new abstraction layer is very useful, because unlike the technologies behind the basic fundamental of the business processes do not change this rapidly.

Enterprise Resources Planning (ERP) Systems, together with Workflow Management Systems (WFMS) have evolved in the past parallel. When we speak about workflow we mean usually as the computerized automation or facilitation of a business process, which covers a part or a whole [51]. Workflow is an automated part of a business process, which executes the work steps in a certain order; information, tasks or even documents are distributed and moved from one participant to the other, who then execute actions following rules on the objects. The main business need and drivers for this kind of automation of course came from the ERP world, but after then WFMS solutions have discovered their own way without ERP, as figuring out the necessity of such applications. Nowadays all the Tier 1 ERP solution providers have their own WFMS solutions standalone from their original mainstream ERP system.

In the final part of the thesis, I demonstrate the connection between the ERP architecture, and the workflow systems during the cloud based operation. These findings underline the significance of workflow automation in ERP systems. The central elements, which carry and handle business data and meaning, are the ERP object. The interoperability of the built-in workflow systems will be presented as key point, then as well describing the required add-on

functionalities, tools to provide usable cross system workflow integration in such an environment. The possibility of using a built-in workflow will be examined, also as a full-featured WFMS. The Workflow is just a theoretical chain of processes and participants assigned with control steps, although the technology enabler is the WFMS. Workflow Management Systems does not only execute the process chains with the aid of software workflow engines, but it has the ability to manage, create and plan them also.

Research goals

It is a very complex scenario to calculate the total cost of ownership of an Enterprise Resource planning system. Those agile methodology-based systems, which are currently used make the whole calculation even more complex, as the agile methodology operates in development cycles, and there is no predefined number of the cycles. It is important to note, that use of Microsoft Dynamics 365 Enterprise Resource Planning system is only for the use test case, that thesis presents methodology which can be adapted to any other ERP system regardless manufacturer. The right structure of the full lifecycle release and maintenance management of an ERP system is a key point of every business entity. Business requirements are always changing, nowadays the change is towards agile methodology, including new role like DevOps in the scope. The previously used model which was widely spread in the last decades, was based on the waterfall-like development release stages where they formed the milestones of the release life cycles.

Software change management methodology is always a complex area, even we are working within the same ecosystem. Business requirements are always changing, nowadays the change is towards agile methodology, including new role like DevOps in the scope. This section covers one of the most challenging change management tasks in a multinational company: ERP system change management, and tris to cover new aspects and new strategical approach to make it more efficient.

The business world as we know them today would hardly even exists if ERP system would stop functioning from one day to another. These are complex ecosystems, often consist of hundreds of sub systems, which works parallel in close connection to each other. The business processes which they represent are aligned with the company goals, therefore they have to be well organized and should provide consistent result even in different conditions. Automation is a key property when we try to improve these processes on management side.

Research methodology

The research methodology which was applied in this research followed a mixed approach, combining a proof of concept theoretical model development and practical case studies. This chapter outlines the systematic process used for creating and validating the results, in respect of cloud-based ERP solutions in small and medium-sized enterprises (SMEs). The main focus was on specifically the reuse of code components and workflow automation in ERP systems.

Proof of Concept (POC) models were developed to validate the scientific results in real-world scenarios. These were implemented in several phases:

- **Phase 1:** Defining the scope of the POC based on business goals and technical requirements.
- **Phase 2:** Creating simulation environments to validate the end-to-end migration process, ensuring that during the transition to clod based environments, all business logic has remained intact during.
- **Phase 3:** Evaluating key performance indicators (KPIs) (system performance, regression testing results, cost analysis) to capture the overall result of the migration process.

Workflow automation validation

The research has another key element, to validate the integration of Workflow Management Systems (WFMS) inside cloud-based ERP solutions. The goal was to automate most of the repetitive business processes with the same scheme, reducing the manual effort. Presented WFMS were tested on both on ERP workflows and cross-system workflows.

Implementation of Agile Methodology

For more efficient guidance of the system development and migration process, the research further applied agile methodologies. Due to its capacity to accommodate changes during the ERP migration process and its flexibility, agile methodology was chosen.

New scientific results and Theses

The primary focus of this research is to explore new methodologies to enhance the migration of ERP systems for small and medium sized enterprises (SMEs) towards cloud based environments. The research addresses lot of challenges related to code reusability, use of platform independent model (PIM), application of agile methodology in ERP change management and workflow management.

Code Reusability when migrating Datacentre based ERP solutions into in Cloud SaaS **[5] [6] [7][16]**

- **Research Gap**: While many businesses aim to optimize cloud-based ERP systems, the broader principles of code reuse across multiple platforms and lifecycle stages remain underexplored, particularly regarding their long-term financial and operational impact.
- **Research Question**: How can general principles of code reusability in cloud-based ERP systems improve the total cost of ownership (TCO) and streamline project timelines for SMEs?
- **Hypothesis**: Implementing methodologies for code reusability in cloud-based ERP systems significantly reduces development time and operational costs while maintaining system integrity.

Platform Independent Model (PIM) for Cloud Migration **[5] [6]**

- **Research Gap**: Generalized methodologies for leveraging platform-independent models (PIMs) in the migration of legacy ERP systems to cloud environments are not sufficiently explored, particularly in the context of long-term operational sustainability for SMEs.

- **Research Question**: How can PIMs be applied to facilitate the seamless migration of legacy ERP systems to cloud-based SaaS platforms, minimizing disruption to core business functions?
- **Hypothesis**: Utilizing Platform Independent Models in ERP migrations significantly reduces migration complexity and risks while preserving essential business logic.

Agile Methodology in ERP Change Management **[3][4]**

- **Research Gap**: While Agile methodologies are increasingly being adopted, their specific impact on ERP upgrades, especially within SMEs, is under-documented.
- **Research Question**: How does the adoption of Agile methodologies in ERP systems affect project success and efficiency, compared to traditional waterfall approaches, particularly in SMEs?
- **Hypothesis**: Agile project management in ERP upgrades leads to higher stakeholder satisfaction and reduced time-to-market compared to traditional methodologies.

Cloud-Based Transition and change management for SMEs **[10] [11] [12] [13]**

- **Research Gap**: Despite the growing body of literature on cloud migrations, there is insufficient research on generalized methodologies that ensure long-term operational sustainability during the transition of ERP systems for SMEs.
- **Research Question**: How can companies ensure sustainable long-term operations when migrating ERP systems, like Microsoft Dynamics 365, to cloud environments?
- **Hypothesis**: Migrating ERP systems to the cloud, utilizing frameworks like Microsoft Dynamics 365, enhances operational sustainability through evergreen system updates and reduced maintenance requirements.

Workflow Management in ERP Systems **[1][2][8][9]**

- **Research Gap**: There is a lack of comprehensive studies that address the integration of workflow management systems (WFMS) across multiple ERP platforms, particularly in cross-platform automation scenarios for SMEs.
- **Research Question**: What are the challenges and benefits of integrating WFMS within ERP systems, particularly when operating across different cloud environments?
- **Hypothesis**: Integrating workflow management systems (WFMS) within ERP systems increases operational efficiency by automating repetitive tasks and reducing manual intervention.

Possible Applications of the Results

The scientific results and methodologies presented in this research hold significant potential in making practical applications, especially in small and medium-sized enterprises (SMEs) while migrating their ERP solutions into cloud-based platforms. The findings emphasize enhancing system usability, optimize the resource utilization, and showing an updated business process workflow. The key areas are presented here, where the previously mentioned results can be effectively applied.

Cloud ERP Migration for SMEs

The methodology developed for code reusability during ERP cloud migration can be implemented across a variety of industries, where SMEs seek to transition their legacy on-premise ERP systems to cloud-based platforms. Worth mentioning that the Microsoft Dynamics 365 ERP system is used only for demonstration purposes, it can be substituted with other relevant product. This methodology is particularly relevant for businesses that rely heavily on existing software infrastructure but aim to leverage the benefits of a cloud environment. By adopting this methodology, SMEs can retain most of the functionality of their legacy systems while modernizing their IT infrastructure, extending the lifecycle of their ERP systems, and reducing the need for extensive redevelopment efforts.

Platform Independent Model (PIM) for Sustainable ERP Solutions

Another key application of this research is the adaptation and usage of Platform Independent Models (PIM) for ERP migrations. This methodology ensures that the underlying business logic of ERP systems remains intact across different platforms, reducing the complexity and risk associated with migrations. PIM can be applied to streamline cloud migrations in a way that ensures long-term system sustainability, particularly for SMEs with limited IT resources.

Agile Methodologies in ERP Upgrades

The research demonstrates the applicability of agile methodologies for managing ERP upgrades and migrations. This agile approach is particularly beneficial for businesses operating in dynamic environments where project requirements may change frequently. Agile methodologies enable continuous feedback loops and iterative improvements, making it easier for companies to adjust to new business needs during the ERP upgrade process. SMEs can apply this agile framework to improve stakeholder satisfaction, reduce time-to-market, and enhance overall project flexibility during ERP system updates. The agile approach allows businesses to stay competitive by implementing changes quickly without the long delays typically associated with traditional project management methodologies

Enhancing ERP Systems for Long-Term Sustainability

This research proposes a framework which has a strong focus on the long-term sustainability, by using evergreen property of the cloud based system, which hides the implementation layer from the users. By focusing on code reuse, workflow automation, and agile methodologies, SMEs can continuously improve their ERP systems without undergoing full system replacements. The cloud-based architecture discussed in this research ensures that ERP systems can be updated with minimal disruption to the business, reducing maintenance costs and ensuring the business remains agile and competitive. This application is particularly valuable for businesses which need to harmonize the modernization of business processes and background infrastructure with cost control, allowing to leverage latest technology without sacrificing operational efficiency and not to exceed the operational budget.

Workflow Automation in Cross-Platform Environments

The integration of Workflow Management Systems (WFMS) into ERP systems is another key practical application of this research. Workflows play valuable role in transforming manual processes into fully or semi-automated processes, which reduces manual intervention to only decision making and giving or updating parameters. This aspect of the research can be applied in sectors where routine, repetitive tasks such as invoice approvals or inventory management are critical components of business operations. By implementing the workflow automation techniques developed in this research, companies can ensure smoother workflows across their systems, even in cross-platform environments. This is particularly beneficial in multi-cloud or hybrid cloud scenarios where integrating ERP systems with other third-party services is necessary.

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