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Investigating ERP System Customization: A Focus on Cloud-ERP

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Abstract

This paper surveys the research on enterprise resource planning (ERP) systems' customization, focusing on Cloud-ERP. ERP system customization refers to the actual alterations of the system on a macro level to meet a specific business organizational requirement or business process. Currently, customization of ERP systems is considered by several researchers and practitioners as a double-edged sword. Hence, ERP systems' customization is often perceived negatively in the ERP literature or as a challenging issue that might affect the system's future updates and upgrades during its life cycle. While the ERP literature is rich, the number of studies focusing on ERP customization is relatively low, and literature within the cloud context is scarce. Thus, this article intends to bridge the research gap and highlight the area around cloud-ERP customization. Based on a systematic review of literature, our main findings show that, while customizations are viewed negatively in general, they are inevitable for some organizations and may provide a competitive advantage when representing a non-standard competitive business process. In addition, most of the current literature argues that the major Cloud-ERP providers do not provide system customization possibilities to most of their clients. And finally, the findings of this research are presented and organized via the five ERP business benefits dimensions introduced by Shang & Seddon.

Keywords: ERP Systems; Customization, Literature review; Conceptual Dimension Model

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1. Introduction

Cloud enterprise resource planning (ERP) systems are modular applications aiming at supporting and integrating the organization's business processes through a unified data repository, where the application and database are hosted in the cloud as a software-as-a-service (SaaS) [1]. Cloud-ERP systems have reported rapid growth in the last decade and stable growth in recent years. The global cloud-ERP market is expected to grow from $36.82 billion in 2021 to $41.73 billion by the end of 2022. This is at a compound and steady annual growth rate (CAGR) of 13.3% [2]. Cloud-ERP systems can be fully hosted, managed, and maintained by a third-party vendor and accessed online by the client organization without needing a local installation at the client's premises [3]. Cloud-ERP systems generally provide lower costs, rapid implementations, scalability and are generally easier to upgrade [3]. On the other hand, cloud service providers control the system customization, updates, maintenance, and upgrades, which may challenge some organizations adopting these systems.

While the ERP systems' literature is quite rich and extensive, little focus was given to the ERP customization topic in general and the cloud-ERP customization in specific. Hence, this systematic literature review attempts to fill the research gap around customization in cloud-ERP systems. The void of cloud-ERP customization is currently being recognized as a significant adoption barrier for some organizations on one side, and as a competitive advantage enabler on the other [4]. Customization was always deemed necessary in ERP implementations, and is also one of the core elements in the implementation phases of several ERP lifecycle models, as the ERP lifecycle framework developed by Esteves and Pastor [5]. Customization shares similarities with the *configuration process*, and the two are often discussed together, and the terms are used interchangeably. However, a configuration is a setting, parameter, or personalization built natively into the software, while customization, contrastingly, will require changes to the system's source code [6]. Customization is, by many, recognized as a double-edged sword. While previous literature argues that as much as 9 out of 10 organizations apply customizations to some degree to solve system misfits, it may complicate things in various areas in the long run [7]. Thus, this manuscript investigates the extant literature on ERP customization with a focus on cloud-ERP to shed light on the current opportunities and challenges, summarize and organize the findings, and identify the current research gaps.

The rest of the paper is organized as follows. Section 2 presents the research methodology employed in this research. Section 3 provides an overview of the selected articles for this review. Section 4 provides an overview and a discussion of the main research findings. Finally, a conclusion, future research avenues, and the impact of this research on literature and practice are presented in section 5.

2. Methodology

A literature review is a suitable way to review existing literature while facilitating theory development and uncovering areas where further research is needed [8].

This review covers articles published over the last twelve years, from 2010 to 2022. For articles to be considered relevant, they needed to be published in a peer-reviewed journal or peer-reviewed conference proceedings. The initial search was completed through Google Scholar, where the search had to include all keywords in the title or abstract. The keywords used were *cloud*, *ERP*, and *customization*. Similar words to *customization,* like *tailoring and modification,* were also included in the search process. Afterward, the titles and abstracts of the identified research were read by the authors to determine if the selected articles were relevant or not. At the start of this study, we were targeting reviewing papers that primarily focus on cloud-ERP customization. However, after conducting the initial search, the authors of this research identified a vast research gap of papers focusing on ERP customization in general, and cloud-ERP in specific. Thus, the selection criterion was widened to include papers that contain the term *customization* in their keywords, and address cloud-ERP customization-related topics, even if they were a side focus of the research. Further, a search in IEEE Xplore, Web of Science, and ACM was conducted using the same keywords. Finally, the authors scanned the reviewed articles' reference lists to avoid overlooking other relevant research articles.

According to [8], a literature review should not be author-centric but concept-centric. The concepts will determine the structure as it will help merge and develop theories and uncover gaps within the area of interest. Therefore, Shang & Seddon's [9] five dimensions for classifying ERP business benefits have been adopted to organize and classify the findings per dimension (see table 1). Namely, the dimensions are operational, managerial, strategic, IT infrastructure,

and organizational. In ERP success evaluation, different measures are needed at different stages in the systems lifecycle, and the list in Table 1 provides a good starting point for comparing benefits for different organizations. In addition, a discussion of challenges identified in the literature is provided under each relevant dimension.

Table 1. Shang & Seddon's (2000) dimension framework.

Dimensions	Sub dimensions (21 in total at this stage)
1.Operational	1.1 Cost reduction, 1.2 Cycle time reduction, 1.3 Productivity improvement, 1.4 Quality improvement, 1.5 Customer services improvement
2.Managerial	2.1 Better resource management, 2.2 Improved decision making and planning 2.3 Performance improvement
3.Strategic	3.1 Support business growth 3.2 Support business alliance 3.3 Build business innovations 3.4 Build cost leadership 3.5 Generate product differentiation (including customization) 3.6 Build external linkages (customers and suppliers)
4.IT Infra-structure	4.1 build business flexibility for current and future changes 4.2 IT costs reduction 4.3 Increased IT infrastructure capability
5.Organiza-tional	5.1 Support organizational changes 5.2 Facilitate Business learning 5.3 Empowerment 5.4 Built common visions

This paper employs Shang & Seddon's dimensions to evaluate how customization is interpreted in a systems view. Consequently, a concept matrix has been developed [8]. This way, it will be easier to compare in what dimension the reviewed articles have investigated or studied customization. This approach could potentially provide various insights into diverse facets, which researchers could consider when approaching the cloud-ERP customization area of research. The dimensions also aid in creating a better perspective of when potential benefits (or challenges) will occur during the various ERP lifecycle stages. [10] points out that benefits realization should be considered an interconnected continuum cycle along the ERP post-implementation.

3. Overview of articles

In total, twenty-three articles were reviewed, divided between twelve journal articles, ten conference proceedings, and one doctoral study. The review shows a relatively new field, with almost 80% of the articles stemming from the previous seven years. An overview of the number of publications over the years can be viewed in Fig. 1 below.

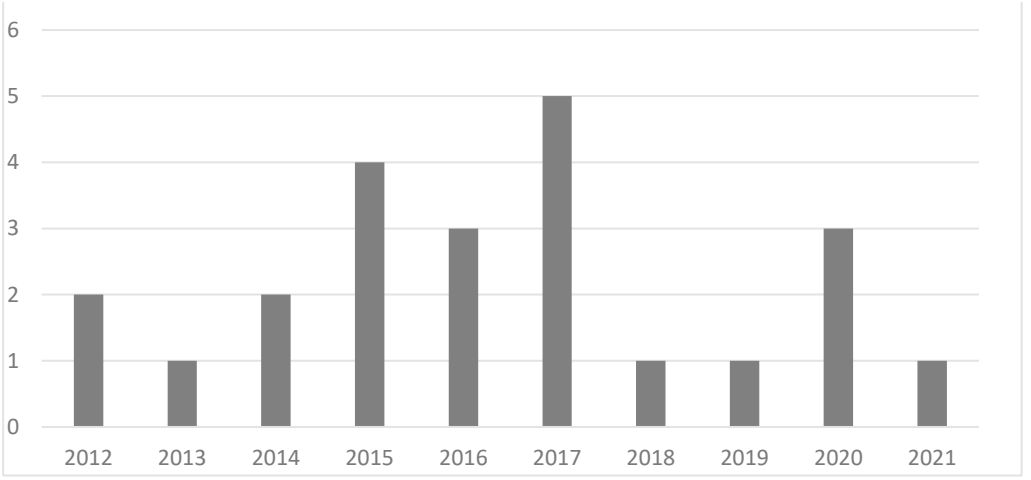

Fig. 1. Yearly overview of reviewed articles.

As mentioned in section 2, Shang & Seddon's dimension framework was adopted in this study to map the reviewed articles' focuses to their respective business dimension that they address. Figure 2 shows that the IT infrastructure dimension has been investigated and reported the most in the extant literature, while the strategic dimension had the fewest contributions concerning the customization of cloud-ERP.

Table 2. Mapping reviewed articles with a business dimension framework.

Articles	**Dimensions**				
	Operational	Managerial	Strategic	IT-infrastructure	Organizational
[11]		x			
[12]				x	
[13]		x			
[14]				x	
[15]	x				
[16]				x	
[17]					x
[18]					x
[19]	x				
[20]			x		
[21]				x	
[22]				x	
[23]				x	
[24]				x	
[25]	x				
[26]					
[27]				x	
[28]				x	
[29]	x				
[30]		x			

[31]					x
[32]		x			
[33]		x			

4. Findings and Discussion

4.1. Operational Dimension

The operational dimension considers operational-related factors that could benefit from ERP systems. Like, such as how well the processes are designed, and how the operations are streamlined. It also covers several other operational sub-dimensions, like cycle times, cost reduction, and customer service operations. ERP systems aid in automating and streamlining processes, specifically when it comes to facilitating cross-functional process integrations. Thus, customization is a central topic within this dimension, as business processes-related customizations frequently occur in large organizations [7]. It can help in customizing the business applications to increase the streamlining of processes [15]. Not only may customizations help business processes to become more efficient, but they can also improve the user experience of the adopted ERP system in general.

On the other hand, customizations add a more significant amount of complexity to the system that ominously requires more extensive organizational experience during the adoption process. Heavy system customizations may also pose challenges for future system updates and upgrades. In addition, business process reengineering efforts often happen before the actual customization of the system. Thus, there is a surprise that some scholars argue that customization (BPR) might potentially affect productivity, both technically and operationally, and might cause issues between the organization and the ERP service vendor. Subsequently, this might be why [25] found customization (BPR) to be one of the main factors for resistance when adopting cloud-ERP. In their analysis, they used customization as one of the variables to test resistance to innovation and system adoption. Interestingly, while customization may affect the cost in terms of IT investment [13, 32] found that it is not necessarily the cost benefits that motivate cloud-ERP implementation. This corresponds to other literature with the general notion that when investing in an ERP system, whether in the cloud or on-premises, the system can help the organizations in the long run and that some organizations regard ERP benefits as self-evident in a broader sense [12, 34].

Customization in the operational dimension is mainly skewed towards improving business processes and achieving more streamlined operations. The main functional problem seems to be when the complexity is more significant than anticipated and when costs are a vital driver for implementing cloud-ERP. When such issues are encountered, it can reduce the project's return on investment (ROI).

4.2. Managerial Dimension

This dimension focuses on the managerial benefits of the ERP systems' reporting capabilities. Mainly, it considers the real-time informational benefits that support senior managers' decision-making [9]. The benefits include better resource management, enhanced decision-making, optimized planning, and performance. Regarding decision-making, customization should undoubtedly be a variable in the requirements analysis [11]. Even though customization does not happen before the actual implementation phase, it is still central to managerial decisions and has to be properly planned before the implementation [13]. Customization requirements could also be part of the service level agreement (SLA) between the organization and the cloud-ERP vendor to reduce potential future cost escalations.

Interestingly, Haddara, et al. [32] found the lack of customizations in cloud-ERP as the second most significant concern of the IT officers' in Norwegian public organizations, only topped by vendor lock-in. Likewise, Abd Elmonem, et al. [11] that one of the underlying reasons for the negative perceptions towards customizations in the cloud is that the cloud-ERP vendors often do not provide sufficient details and descriptions of the limited, and customizable aspects of their systems, which ultimately leads to a much more complicated project. The paper also suggests that customization and integration requirements would lead to an SLA of greater complexity, but this only signifies the importance of such requirements [11]. [29] found that some trade-offs eventually need to be made for customization efforts to succeed in a multi-tenant SaaS environment. This corresponds with other research [33], which

developed a customization model that illustrates a) how key stakeholders' engagement and interaction influence customization processes, and b) how the actual benefits resulting from cloud-ERP customizations are realized. However, customization is not something that needs to be a part of every cloud-ERP implementation, as it all simmers down to what requirements are regarded as essential [13].

4.3. Strategic Dimension

The goal of the strategic dimension is to aid in identifying the areas that could achieve a competitive advantage for businesses. The primary operations and areas that fall within this category are, for example, differentiating, innovating, supporting business growth, and focusing on the right alliances.

Today, many organizations use multi-tenant SaaS, which offers the same product or application for all users. In literature, there are some conflicting views on the topic of customization. Some view customization as a strategic tool that can create a competitive advantage by differentiating the cloud-ERP solution to echo competitive business processes. It will be much more challenging when attached to the same system as competitors [4, 31]. In addition, some studies argue that customization would work relatively cheaply when realizing that the cloud-ERP system can be utilized to differentiate and that the investment is justifiable [31]. Other studies also acknowledged the void of customization possibilities for cloud-ERP clients, especially SMEs [4]. Likewise, Nowak and Kurbel [24] point out that the vendors' customization strategies usually limit the customization options. There seems to be a discrepancy between what the cloud-ERP vendors claim to offer and what they offer. Therefore, it becomes even more critical to identify the strategic requirements related to the customization plans. Hence, a proper strategic analysis framework must be implemented to implement a cloud-ERP system with suitable customizations that make those strategic plans attainable. For example, this can be done by applying requirements identification strategies and other software selection strategies, this will make the customization plans more evident to the client and vendor, and the customization limitations can be eliminated by the vendor, in some cases [20]. Thus, customization plans are tightly connected to the managerial dimension and may affect the whole cloud-ERP adoption experience. Many innovative IT solutions would help a company differentiate, innovate, and grow to connect to the next dimension. For example, [16] claims that a more flexible, customizable IT solution will allow organizations to meet their requirements and increase their competitive advantage. In other words, a good ERP strategy that allows room for customization could significantly benefit a company. Finally, Ahn and Ahn [25] argue that customization, and its view will also vary from country to country. It is also concluded by Hustad, et al. [7] that ERP vendors that want to grow in specific national or regional markets should consider the standards for that country or region.

Our findings suggest that organizations need to consider customization when laying down strategies for implementing a cloud-ERP system. This point is tightly interwoven with the managerial findings for businesses. The main areas to gain a competitive advantage are differentiating, innovating, supporting business growth, and focusing on the right alliances. Customization can help companies differentiate, innovate, and grow. However, the vendors' customization strategies may limit the customization options.

4.4. IT Infrastructure Dimension

The IT infrastructure dimension comprises shareable and reusable IT resources that provide a foundation for future business applications [9]. Flexibility, IT cost, and capability are central areas to explore within this dimension. So are developing new frameworks, platforms, or ways to build and customize how cloud-ERP should be constructed for companies. Nowadays, most cloud-ERP providers offer a similar SaaS service, which means the cloud-ERP providers host and manage all the IT infrastructures for an organization, help ensure the system is run uninterruptedly, that data is securely protected, and that product improvements are rolled out painlessly [12]. However, those systems are inflexible, and more flexibility and customizability seem to be a common denominator in research and organizational needs [22].

One such solution proposed is a framework that may improve flexibility to multi-tenancy SaaS environments by adding an application manager that lets the users have the same SaaS experience, yet with room for free customization possibilities for their clients [16]. In this scenario, multi-tenancy application managers can enable an organization to access the security features, an application builder, and a customizing manager. Another solution is to elevate ease by

employing a web service composition method for cloud platform providers to speed up, automate, and outsource the customization process to their clients. Chen, et al. [26] explain that this can be completed by using genetic algorithms and a collection of rough set rules. A similar outcome, but with another approach, can be achieved through building software product lines (SPLs) [21]. SPLs refers to software engineering methods, tools, and techniques for developing a bundle of similar software systems from a shared set of software assets using a shared means of production. SPLs can provide a managed set of features satisfying the specific needs of a particular market segment or mission developed from a standard set of core assets in a prescribed way [35]. SPLs have been introduced by several prominent ERP vendors for decades, offering pre-customized and configured systems targeting a specific industry or business area (e.g., automotive). Ali, et al. [21] mapped the essential roles within the project that are needed to communicate and customize an SPL-centered system using a requirements elicitation approach. While SPLs are a way to reduce the need for further customizations, however, they are still not *individually* customized and follow the industry's best practices.

Another complex solution could be to implement infrastructure as a service (IaaS) on ERP, where consumers can directly use independent virtual machines that isolate the underlying physical hardware of the cloud from them [14]. It is the cloud provider's responsibility to operate the IaaS. Still, the organization's responsibility is to find an ERP system package and system license and implement the system to the IaaS. This seems to remove many infrastructural limitations around customization, however complex, costly, and resource-consuming. A hybrid solution is also possible where the most resource-demanding modules are kept on-premises or hosted privately. In contrast, the less critical ones are deployed in what has become a more standard multi-tenant cloud-ERP [28]. Moreover, since the cloud-ERP market has attracted many new vendors, finding a system that fits the organization's needs should be virtually possible.

4.5. Organizational Dimension

Several organizational characteristics might affect the need for customization. This dimension takes a broader look at how an organization's structures and processes are affected: organizational changes, business learning, and the general empowerment of employees, and points out that larger enterprises will have a much more vital need for customization. However, the organization's size affects customization needs the most regarding this organizational dimension [17]. For example, a large organizational size might implicitly suggest that those organizations have competitive processes, legacy systems, and other factors that would require more flexible integration and customization solutions. Large organizations usually own complex legacy systems from the past to be integrated into a modern cloud-ERP [28], which may be a horrid experience if choreographed inadequately, and this can become an issue when combining *heavy* modules such as finance, manufacturing, or supply chain management [30]. Furthermore, organizations that insist on customizing applications to suit current business processes may report failure due to unwillingness to implement organizational changes [14].

While large organizations usually have complex systems in play, SMEs have limited modules and may not need as much customization [18]. Hence, it is unsurprising that some large enterprises were more resistant to adopting a cloud-ERP solution. On the other hand, SMEs can more confidently choose a cloud-ERP approach closer to a vanilla system. While it could positively affect productivity, cost, and performance, it would include a minimal number of customizations in the system. Lastly, employees can also affect how customization issues are handled, as the right team of experts can help overcome them [12].

The organizational phase was the most challenging dimension to map to customization. This can be due to the scarce literature, but it can also be due to the chosen framework to frame this review. The literature suggests that a company's size will affect the customization needs and requirements. Larger enterprises will, in most cases, require more tailoring, while SMEs may implement a cloud-ERP system closer to the vendor's vanilla system. Others suggested that private cloud infrastructures could be a resolution to the customization inflexibility of the cloud-ERP vendors [36].

5. Conclusion and Future Research Avenues

This review has reviewed twenty-three articles across various peer-reviewed conferences and journal outlets. The geographic location division of the articles and case studies in the literature demonstrates a global reach of cloud-ERP implementations. In general, few articles focused squarely on customization in a cloud-ERP context. Although there is a surge in cloud-ERP research, it would be interesting to see a more holistic understanding of elements or phases that make up the ERP lifecycle in the cloud. The extant literature shows a consensus regarding the positive correlation between customization and implementation complexity.

On the other hand, there are no clear guidelines for when customization scenarios are needed or which type of customizations are paramount for what type of business. Thus, this research attempted to map the customization efforts to the potential areas they may affect. The literature reported that the majority of cloud-ERP vendors do not provide customization services. In addition, there are conflicting reports about the possibility of customizing cloud-ERP in general, but it appears that customizations are only offered to large and *important* clients.

This article can have implications for both research and practice. For practice, this paper would benefit technical managers and cloud-ERP vendors by underpinning the importance of customizations and their impact on business benefits. In addition, the findings recommend that cloud-ERP vendors should consider developing modules or interfaces that can aid organizations in customizing their applications, or at least provide some limited customization options. For research, a business benefits framework was employed to explore the type of customizations and map them with their expected business benefits and areas of enhancement. Further, this research provided an overview of the cloud-ERP customization landscape in current literature and the benefits and challenges of customizing ERP systems in the cloud.

Future research could collect empirical data from customization tool managers to investigate how the customization decision process occurs in organizations. It would also be interesting to investigate the possibility of developing customization frameworks or guidelines that can provide an overview of the most common customizations, their positive business impact, and their consequences on the application layer. While several lifecycle models and frameworks exist for on-premises ERP, this study could not identify any research that addresses the cloud-ERP lifecycle. Hence, scholars are advised to investigate the phases a cloud-ERP goes through in its lifecycle and if it differs from traditional ERP lifecycles. Understanding the cloud-ERP lifecycle phases and their associated activities may lead to better customization strategies and enhance our understanding of cloud-ERP in general. Finally, this research recommends that organizations have an open dialogue with the cloud-ERP vendor to influence the service offered, as there seems to be a discrepancy in their service offerings among their customers. While it might be very costly and complex, however, private cloud infrastructures could be a solution to the customization issue.

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