CENTERIS – International Conference on ENTERprise Information Systems / ProjMAN – International Conference on Project MANagement / HCist – International Conference on Health and Social Care Information Systems and Technologies 2022

Customizing ERP-systems:
A framework to support the decision-making process

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Abstract

Enterprise Resource Planning (ERP) systems are standardized software packages based on industry "best practice." Despite this off-the-shelf property, most companies that implement an ERP system choose to customize the software rather than change their business processes. Customization, however, represents a double-edged sword: on the one hand, it can provide improved functionality, increased user quality and satisfied users; on the other hand, it can bring significant risks to the company due to increased implementation costs, increased complexity, and expenses for subsequent upgrades. Interviews were conducted with ERP experts, and empirical findings contain different drivers and consequences for enterprises that choose to customize ERP systems and highlights related challenges. The purpose of the study is to develop a framework with accompanying guidelines that can help companies, in cooperation with suppliers and consultants, to better handle customization decisions in ERP projects.

Keywords: ERP systems, ERP customization, standardization, process changes, decision-making framework.

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1. Introduction

Enterprise Resource Planning (ERP) systems are the most expensive digital technology investments that companies undertake to maintain competitiveness [1, 2]. These systems are sold by several different vendors, who all promise certain benefits: improved technical and organizational performance, better customer care and increased control for managers and decision-makers [3]. In addition, these systems improve the company's overall IT architecture and remove redundancy and incompatible silo solutions, thereby reducing overall maintenance costs. ERP systems are standardized, integrated software solutions based on "best practices" from different industries [4]. They handle organizational resources and ensure seamless integration of data across departments and functions. An ERP system represents the backbone of a company, and its transactions include everything from finance and project and human resources to the value chain, logistics and customers.

However, ERP implementation is not easy; these module-based systems are highly complex and force changes in business processes, work routines and the roles of employees [5]. ERP implementation experts are also urgently needed because technical setup and configuration, as well as end-user training, are challenging. Because of these complexities, many ERP systems fail to realize their potential value as implementation costs exceed their budget or the final system does not fulfil company expectations [6].

Standardization is among the most important features and benefits of an ERP system; however, standardization also creates challenges. ERP systems have predefined business rules and procedures that determine how business processes will work and can therefore be implemented in many different organizations. However, these predefined rules will never completely correspond to the implementing organization's existing processes and practices [7, 8].

In most cases, ERP systems cannot improve corporate productivity and efficiency without the organization also adapting their business processes to the ERP system's rules. Therefore, during ERP system implementation many organizations undergo radical and complex process changes, called business process reengineering (BPR), to realize the potential of the new system [9]. Compatibility between an organization's existing processes and a new ERP system is an important goal for achieving successful ERP implementation. The "misfit", "mismatch" or "misalignment", or "gap" describes the differences between the ERP system functionality and the requirements and needs of an enterprise [10].

To reduce the gap between the predefined rules of an ERP system and organizational processes and practices, the ERP system is often customized, or tailored, by implementing different system modifications, for example code modifications or the addition of new functionalities and applications, as well as changes to user interfaces and standard reports [11]. ERP system customization can thus provide improved functionality, increased user quality and benefits for users [12]. On the other hand, customization can also bring significant risks to the company due to increased implementation costs and increased complexity for subsequent upgrades [13]. Customization of ERP systems thus constitutes a double-edged sword: it provides benefits, but they are expensive and create serious challenges for the future. It is emphasized that it is particularly important to have appropriate expertise when dealing with the gap between ERP system standard functionality and the organization's unique requirements, as there is a high risk associated with customizing ERP systems [14, 15]. However, it is not clear from the literature how companies should decide whether to customize an ERP system to their needs, or whether they should instead change their business processes to fit the standard ERP system [11]. Moreover, customization of ERP systems may gain benefits for the end-users, however, can negatively affect the software quality [16]. Many organizations have trouble in making this decision. Thus, the following research question has guided our study: *How can the decision-making process for ERP customization issues be supported in enterprises?*

We conducted a case study comprising 10 interviews with experts to identify the drivers and consequences of ERP system customization. We propose a framework, with associated guidelines, that can help stakeholders decide whether ERP customization is most appropriate for their organization. This framework, along with an improved understanding of the drivers behind customization, can reduce unnecessary customizations.

2. Research context and method

This study was initiated to identify customization issues and challenging trade-offs related to customization decisions in ERP projects. The purpose was to develop a framework with associated guidelines that can assist

stakeholders in making customization decisions. The participants of the study were either consultants working for a one large consultancy company – Consult (pseudonym) or this company's customers.

Consult is one of the world's largest providers of professional auditing, consulting, and legal services, comprising about 244,000 employees in 150 countries. In Norway, Consult has approximately 1,300 employees at more than 20 offices. Their clients span the full spectrum of Norwegian businesses, including non-profit organizations, municipalities, and governmental sectors providing consultancy services in ERP implementation. They have extensive experience customizing ERP systems and perform several types of customizations; (1) screen-level customization—screenshots and display buttons (GUI); (2) query development (SQL) and definition of the jobs that work in the background to automatically perform defined tasks in the system; and (3) core framework customization. For all three categories, long-term maintenance costs are often underestimated despite the consultants providing advanced information about the customization's risks and costs.

We conducted an interpretive case study [17] in Consult and its customer context, to understand how ERP and customization occurred in practice. The primary data source in the study included 10 semi-structured expert interviews [18], in addition to secondary material of relevant documents (e.g., project documents, requirement specifications). Eight of the interviews were conducted with Consult's customers, and two interviews were conducted with internal consultants at Consult. The interviews lasted approximately one hour. The companies involved in the study, were medium to large enterprises, and customization of on-premise ERP solutions was the main focus.

The participants in the study had extensive experience with ERP projects and customization between 5 and 10 years or more. The content of the interviews was therefore retrospective, and the findings represented stories and events from both ongoing and completed ERP projects in which the participants were or had been involved. The participants had extensive knowledge of the phenomenon, which contributed to interesting discussions and reflections during the interviews. The interviews were largely dialogue-based [19].

3. Main findings of the study

The main findings are discussed based on four main questions:(1) What are the risks of customizing ERP systems? (2) How do stakeholders make decisions about ERP customization (3) What are important inputs to the decision-making process? (4) What expertise and knowledge are needed to successfully execute ERP customization? The results provide a framework to better support stakeholders in their decisions about ERP customizations (Figure 1).

3.1. Risks of ERP Customization

The biggest challenge for ERP system customization is the difficulty of providing future upgrades to the system. It is well known that systems undergoing a lot of customization will have a more complex and more expensive upgrade process in terms of scope, costs, and system downtime. Overall, customizations increased complexity and problems.

Several of the system administrators and consultants had experience with complicated upgrading processes. If the initial customizations were poorly documented by the programmers, this sometimes led to problems when new consultants or internal employees assumed responsibility for the system or its upgrades. In addition, more training was needed for new system administrators. Lack of expertise and knowledge transfer when consultants and internal system administrators were replaced created problems with new adaptations or upgrades of previous customizations. Customizations and subsequent upgrades require very good programming skills, and a lack of programming competence was highlighted as a risk. Few system developers possess this expertise in the market. If initial complex customizations were implemented by expert consultants without proper documentation, maintenance and upgrades were especially challenging in the post-implementation period.

Systems that were highly customized also required more comprehensive test procedures and version handling in upgrades. It was important to have good internal competence on the system's framework, data model and database to be able to participate in upgrading processes in cooperation with consultants. It was challenging to handle problems when systems were highly customized, and it could be difficult to determine whether problems were due to adjustments or other reasons. Often, a consultant could find a "patchwork" of past adaptations, and a documentation was lacking. It was important to keep track of the customizations that were made; in some cases, one customization could invalidate another. Many companies ordered customizations before understanding what was provided by the

standard system. Thus, it is possible that unnecessary customizations might have been purchased. Customizations should benefit a minimum percentage of users to be implemented. The standard ERP system sometimes lacked the ability to perform functions that were crucial for maintaining a company's key processes. The system vendor typically takes a long time to implement customer-requested functions and respond to customer error reports. Vendors may not prioritize the development of customized functions when their development costs exceed their expected earnings. It was crucial to include customization as a point in the risk matrix prepared at the start of an ERP project. In some cases, it was hard to get an overview of the history of adaptations, and the overview of the system was lost.

3.2. Making Decisions about ERP Customization

Our study sought to understand how recommendations for ERP system customizations were created and decided on within organizations. Who really made the decisions, and how were requests for customizations handled? Our results indicated that there was no common procedure for this; both more and less rigid decision-making processes were used. Typically, users from different departments came up with requests for customization, but in some cases only the IT department decided on customizations to be implemented. Some organizations distributed the decision process across departments who made customization suggestions based on a local department need. In these organizations, system administrators had to be aware which department had requested specific customizations and consider their competence and motivations. In many organizations, customization decisions were made in the design phase. An interesting observation was that many decisions about customization got commitment several years after the system was implemented. The influence of individual employees and/or company policies and power structures could influence customization requests. Maintenance and management costs were typically underestimated, and costs were not considered early enough in the process. Overall, participants agreed that it was necessary to develop a business case for each customization wish to assess the costs in the requirement specification.

3.3. Input during the Decision-Making Process for ERP Customization

Several of the participants in the study emphasized that their organizations wanted to have a pro-active perspective regarding ERP customization decisions to avoid ad-hoc undertakings. It was important for decision-makers to understand the standard ERP system well and have knowledge of standard ERP system functionality. The standard system should be tested before customization decisions were made. Nevertheless, several of the participants emphasized that this process was not always well-planned: while it was recognized that a cost-benefit analysis should be performed, this was not always implemented, leading to potentially unnecessary adjustments.

Similarly, participants emphasized the importance of reviewing standard processes before developing a list of potential customizations. In some cases, the implementation timeframe was also assessed: should the organization keep to the timeframe and tolerate poor functionality in the first period after the system went live? The Project Manager for the ERP project has a major responsibility for making the right customization decisions based on the most critical needs. Participants agreed that they should avoid cosmetic changes, clarify risks, and implement change-management procedures to avoid customizations initiated primarily based on resistance to change.

Some of the system administrators claimed that they assessed whether there was proper expertise in the market; was it possible to hire skilled consultants to implement customizations and ensure appropriate maintenance? In addition, they examined the status of the software vendor: were they planning to develop the functionality that was desired in near future?

It was important to get an overview of the processes that the ERP system supported, so that the necessary modernization of existing business processes in the enterprise could be carried out to fit the system. It was crucial to identify poorly functioning processes to avoid adding new functionality to support a non-efficient process. A process-improvement approach was emphasized to improve business processes instead of customizing the system if a process was cumbersome. The consultants participating in the study wanted to avoid unnecessary customizations and put forward the importance of conveying this information to the organization.

A few of the organizations in the study had established a panel or control board to recommend changes and make decisions about customizations. This panel made assessments related to the organization's business case and evaluated whether the changes would lead to good results. Other organizations had established several priority forums to make

decisions, depending on the type of change. In these priority forums, internal, external, and regulatory requirements were also considered. Some organizations conducted impact and risk assessments, but this was not a very formal process. It was common to involve consultants for advice regarding customization decisions. Participants emphasized the importance of participating in system user forums, to provide input on new functionality developments. Some of the study participants also stated that they were very careful in selecting customizations; their overall goal was to use the shelf product as much as possible and adjust their businesses processes accordingly.

3.4. Expertise needed for Executing ERP Customization

In some cases, adaptations could be complicated, because several different consultants had been involved without having a complete overview. It was therefore important that the system administrators had control over the business processes associated with customization. The internal system administrators were an important link between the internal organization and the vendor and consultants. It was found that process owners who had less professional competence on the ERP system had greater problems in knowing what to order from external consultants. Competence in customization, as well as training within the organization, were generally important to ensure good decisions. Lack of expertise can also result in not adapting the system, even when adapting is the best solution and is necessary to ensure benefits and good quality of use.

An IT-owned solution could be unfavorable because the focus was too much on the technical aspects, while a business-owned solution would focus more on efficient business processes. Collaboration between IT and business were crucial to make the right decisions. Both controlling the processes and knowing how the system was designed were considered necessary for deciding on customization. A good balance between internal and external competence was also essential.

4. Developing a decision-making framework for ERP customization

Figure 1 summarizes the results into a framework that shows the relations between elements that are crucial when making ERP-system customization decisions. The purpose of the framework is to support stakeholders when they are leveraging complex ERP-customization tradeoffs. Based on the results, we were able to identify the key reasons for customization as well as its benefits, disadvantages, risks, and consequences. Essentially, the crucial elements are possessing the skills or gaining the correct skills to make important decisions and finding the right balance when considering when to tailor the system or when to tailor business processes. In addition, it was important to establish a board of decision-makers who could assess and evaluate business cases and make decisions about whether customization should be executed. The timing of customization was also important. It is recommended that organizations know the system well and be accustomed to using it before they consider customization. In many cases, customization is done prematurely, when an organization does not know all the functionality in the standard solution. Organizations that dealt with customization experienced minor problems about long histories of adaptations. It was also important to postpone customization to address user concerns, although, in several cases, input from users was due to resistance to the new system and not based on real needs. The organization would then customize the system so that users get functionality like what they had before, and the risk could be that cumbersome processes were maintained.

We recommend a *Decision-Making Board* of different expertise to review the customization proposals. Based on the pros and cons of each customization and how it relates to the organization, the board develops a business case comprising a cost and benefit analysis and risk analysis. The business case should consider the pros and cons of implementing customized solutions and should also assess whether the organization should adapt its business processes to the system rather than customize the system. It should also indicate whether customization is recommended in whole or in part. The business case provides the necessary information for decision-makers, whether they are part of the board or not. The *Decision-Making Board* should comprise a competence group for making customization decisions and the board should include the following roles: (1) *Project Manager* for the ERP project. This person can be either internal or external, should be involved in terms of risk and cost, and is responsible for the progress of the project; (2) *The CEO and CIO*, who should be involved in terms of risk and cost; (3) *Process Owner/Subject Matter Expert*; an internal resource who knows the process well and can help design customization

requirements to best support the process; (4) *End User*: an internal resource who knows the process well and, from a different perspective than the Process Owner, can help design customization requirements to best support the process; (5) *ERP System Vendor*: This usually external stakeholder must know the ERP system's history and future development plans in order to provide information in case the desired functionality will be standard in the next version; in this way unneeded customization can be avoided. This person should also be aware of the consequences of customization; (6) *ERP Customization Expert*, either internal or external. It is important that this board member know the ERP system and programming language well and understand the technical consequences of customization; (7) *ERP System Expert*, either internal or external. This member must know the ERP system well.
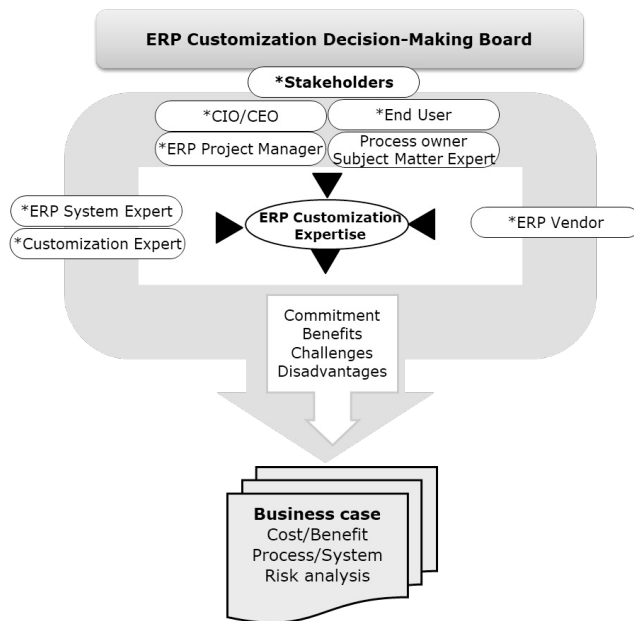
In sum, the framework emphasizes six critical elements (Fig. 1):

1. *To have broad expertise and knowledge on ERP and customization*
2. *To have structured approach to customization decisions (through advice from the board)*
3. *To assess the benefits*
4. *To evaluate the challenges and disadvantages and degree of commitment*
5. *To develop business case documenting risk, costs, and benefit evaluation*
6. *To consider pros and cons for business process customization and/or customizing the system.*

In addition to the framework, the following 10 guidelines are proposed to support the decision-making process for ERP customization issues (Table 1). The framework and guidelines together can provide the different stakeholders in the board with a foundation for improving their customization decisions in ERP projects.

Fig. 1. Framework for Supporting Decision-Making Process for ERP Customization.

These guidelines must be regarded as critical for achieving an optimal ERP solution were maintenance and upgrades are manageable, the system is efficient, while maintaining consistently good quality of use across the organization.

Table 1. Guidelines to Support ERP Customization Decision-Making.

Guideline #	Description of guideline
Guideline #1	*Provide access to proper expertise regarding customization of an ERP solution*. This will depend on the size of the IT function within the organization. Small businesses will be more vulnerable and more dependent on external expertise through system vendors and consultants. It will be particularly important for small businesses to establish good relationships with consulting firms so that they have permanent consultants who know the organization and system in detail after implementation. Larger companies with their own IT departments will usually have internal experts who know the consultancy market and know where to get the skills needed for important decisions regarding customization.
Guideline #2	*Establish a board with the appropriate skills that can evaluate and prioritize input to customization of the ERP solution*. In larger organizations, it is important to have formalized processes for decisions about customization. Customization will have consequences for many users and various departments with diverse needs. This can in many cases involve complex business cases, so setting priorities is critical. For smaller businesses, it is also crucial to have a structured approach to customization to avoid ad-hoc decisions and unnecessary customization early in the project. Previous studies have shown that ad hoc approaches to customization result in high costs and delays in the ERP project. Again, small businesses are particularly vulnerable to ERP budget overruns and, in many cases, will benefit the most from keeping the customization of the system to a minimum.

Guideline #	Description of guideline
Guideline #3	*Always carry out a risk analysis before customization an ERP solution*
Guideline #4	*Always evaluate the costs and benefits before customization an ERP solution*
Guideline #5	*Avoid customization at an early stage in the ERP project*
Guideline #6	*Get to know the standard functionality of the ERP system before customization.* Guideline 3-6 are linked and constitute an important part of good project management in ERP projects. Unnecessary customization may in some cases be a symptom of lack of control over the ERP project, for example, when additional orders are added to the project that were not included in the initial requirement specification. A risk analysis for the entire project, in which the degree of customization is an important element, is therefore crucial. If an organization does not adequately know the standard functionality, it is at risk of customization too early in the project.
Guideline #7	*Limit customization by focusing on change management, lean business modeling, process improvement.* It is important to evaluate the company's internal business processes before embarking on extensive customization. ERP projects can be important drivers to ensure the continual improvement of processes (using the lean approach) and removal of bottlenecks. Modernization of processes can provide competitive advantages and help the organization adhere more closely to best practices, better matching organizational processes with ERP-system processes. The results show that customization will affect upgrades in both the short and long terms, making maintenance costlier and increasing the risk of errors in the system; this is supported by earlier research. It is especially important to get an overview of attitudes toward the system in the organization. There may be instances where organizational factors affect the desired specifications of customization because of change in the organization. The organizational culture resists changes, and users want to maintain established routines and functionality as in previous systems. Excessive customization can be a sign of the organization's inability to adopt new processes, so it may be important to implement change management, among other things, to communicate the benefits of a new ERP system and to counteract resistance by emphasizing the value of the new system [5].
Guideline #8	*Customize the ERP solution only when it significantly increases quality and efficiency for users.* There will rarely or never be ERP projects in which customization can entirely be avoided. In some cases, it is also important to carry out customization to maintain a unique business process that is not supported by the ERP system. Decision-makers must weigh possible user resistance against benefits for users. An adaptation that leads to higher user acceptance because it delivers functionality desired by many end users can by itself increase an organization's performance. Resistance to the system may cause the system to malfunction or to be circumvented through workarounds, which can create subsequent problems when the organization no longer trusts that the system will be updated or when it does not display real-time data [20].
Guideline #9	*If there are several suggestions for customizing the ERP solution, develop a priority list of customization requirements.* If there are several inputs from various departments in the organization that want customization, it is important to prepare a business case for each customization and rank them in priority for development and implementation. In some cases, input will be rejected after an initial screening because the customization cannot be implemented for one reason or another. It is also important to wait until the system has been in use for a period before considering an adaptation.
Guideline #10	*Participate in user forums to influence the ERP vendor to develop new functionality that can be included in the standard.* An ERP system usually has a long lifecycle [21], and the system vendor will continually update the system through new versions with improved functionality. Here, the user forum for the system is an important player in the ERP ecosystem, providing a medium for requests for new functionality and improvement [22]. There may be diverse practices in how such forums work, and in some cases the most influential customers (the largest companies) will exert the most influence on the system vendor's choices and best practices [23]. The present study showed that the user forum functioned democratically. Nevertheless, some customers claimed that waiting times were too long for a new version containing a specific functionality and that therefore they chose to tailor to get what they wanted more quickly. Nevertheless, it is important to participate in the forum to ensure a degree of influence on the ERP vendor. It can also be important that, when signing a contract with a vendor, it has been confirmed in which version a desired functionality will appear.

Based on the framework and guidelines, the board should present proposals for solutions, addressing pros and cons, so that decision-makers have the best possibly foundation for making a well-informed decision.

5. Concluding remarks

This study has focused on the customization of ERP systems and proposes a framework with associated guidelines that can support organizations in deciding whether to customize an ERP system or not. The study provides perspectives on ERP and customization from both the consultant and the customer's side. The framework combines both

perspectives, which are coincidental but also different. A general perception is that consultants wish to minimize customization more than customers do. External consultants and system vendors see more benefits from using the standard solution, avoiding customization, because customization presents challenges about continued maintenance and upgrading of the system. The customer, on the other hand, will in many cases prefer customization to avoid changes and resistance within the organization. However, by establishing a board with different stakeholders that collaborate, we believe that the framework and the guidelines can support the decision-making process, and thereby avoid ad-hoc solutions that provide serious concerns for the ERP solution in the future. The board for ERP customization decisions that is part of the framework (Figure 1) is also of interest for further research. Deeper insights into how such boards work in customer organizations, as well as comparisons between established boards in diverse organizations, could provide more detailed knowledge about how decisions are made. The framework is based on the results from on-premise ERP customizations, and only one consulting company and its customers were studied. Further studies should therefore focus on other organizations, and customization decisions associated with cloud ERP needs more attention. The framework including guidelines for ERP customization can then be revised and finetuned.

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