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Functional Analysis of Open Source ERP Systems – An Exploratory Analysis

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Heft 2



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ERP Systems – An Exploratory Analysis

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1 Introduction

Over the past years open source (OS) software (OSS) has spread in many areas indicating an increasing maturity and acceptance of this emerging technology. Among the most prominent OSS examples are the Linux operating system, the Apache web server and the GNU C compiler. While most open source products are well known and adopted in the system software area, they have also spread increasingly in the application software domain. Among the examples are OpenOffice, the Mozilla Firefox browser or the Thunderbird e-mail client [Vaughan-Nichols 2005]. According to a Gartner research the \$92.7 billion software market in 2006 includes about 13 percent of OSS products and its share is expected to rise in the future [Galli 2007]. However, these applications usually do not include any specific business logic. As described by [Kalakota/Robinson 1999] this is the domain of electronic business applications such as supply chain management (SCM), customer relationship management (CRM) and, of course, enterprise resource planning (ERP). Proprietary packaged software systems are available in the market from commercial vendors such as SAP, Oracle and Microsoft. These so-called commercial-off-the-shelf systems (COTS) typically require significant resources for obtaining licenses, customizing the system to a company's requirements, maintaining the system with upcoming releases, running the system and the like. In contrast, OSS is among other things attributed with security [Hoepman/Jacobs 2007], flexibility, low hardware requirements, and lower costs due to no license fees [Cybersource 2004].

Previous research on OSS has primarily focused on the motivation of contributors, the innovation process itself, and the competitive dynamics [von Krogh/von Hippel 2006]. Only marginal attention has been given to OS enterprise systems, an area where most companies have started implementations of packaged software and which has a direct link to business value. This paper addresses this gap. In fact, successful implementation stories are reported from small and mid-sized enterprises (SME). For example, Infoterra, an EADS company, implemented ERP5 to support its order management process [Quack 2006] and Mango Network uses Compiere as a foundation for their own ERP software [Santossus 2006]. However, OS ERP are far away from being widespread and the literature focuses on the analysis and comparison of OS ERP projects [Herzog 2006], [Kim/Boldyreff 2005], [Serrano/Sarriegi 2006] or specific aspects such as the viability of the OSS paradigm for the development of enterprise systems in single OSS or mixed scenarios with proprietary software [Dreiling et al. 2004], [Dreiling et al. 2005] or the provision of web services technology for an OS ERP system to enhance its flexibility [Kurbel et al. 2006]. This research aims to enhance the understanding of OS ERP systems regarding their business functionality and the evaluation process. Among the results are strengths and weaknesses of OS ERP systems as well as insights regarding their potential. Finally, an agenda for further research is presented.

The next chapter describes the research methodology, followed by the functional analysis of three OS ERP systems in an order management case setting. The last chapter concludes with limitations and discussions of the key findings.

2 Research Methodology

Research on OSS is available from different disciplines and focuses the nature of OSS development, OSS projects as well as their impact on competition in the software market. [von Krogh/von Hippel 2006] summarized the existing research in a framework consisting of three areas. The first one is the *motivation for contributions* of individuals and the impact of firm's or community participation on their motives. The second area deals with *governance, organization, and the innovation process* of virtual communities developing free software. The third branch of research looks at the *competitive dynamics* of OSS and the consequences for the commercial software market and vendors. The downside of this framework is that business benefits of OSS users and research on adoption of OSS in the companies are not in its scope. A more comprehensive view on OSS was developed by [Niederman et al. 2006]. They propose a multi-level research approach for the OS domain which addresses issues at several levels including (1) the artifact, (2) the individual, (3) the group, project or community, (4) the organization, and (5) the society as a whole. The five levels and examples for research issues are summarized in Table 1.

Levels of analysis	Variables	Research issues
Artifact	<ul style="list-style-type: none"> – Artifact type (infrastructure, package, application, cross-functional application) – License type (restrictiveness) – Quality of product (fewer bugs, better security) 	<ul style="list-style-type: none"> – Contrasting open source and proprietary artefact characteristics – Precursors to the choice of license type – Effect of license type on diffusion and use of software
Individual	<ul style="list-style-type: none"> – Developer – User 	<ul style="list-style-type: none"> – Motivations for participation – Choice of project – Adoption decisions
Group, project, community	<ul style="list-style-type: none"> – Organization governance (hierarchy, use of decision committees) – Mechanics for artefact creation 	<ul style="list-style-type: none"> – Mixtures of paid and volunteer developers – Processes for modularizing projects, assigning work tasks, evaluating and integrating new code – Communication processes and patterns
Organization	<ul style="list-style-type: none"> – Developer – Distributor – Users 	<ul style="list-style-type: none"> – Business models for developers and distributors of open source software – Total cost of ownership for investing in OS – Mixtures of open source and proprietary software over a whole MIS department
Global	<ul style="list-style-type: none"> – Influence on society 	<ul style="list-style-type: none"> – Diffusion of the open source “philosophy” to other areas such as licensing of intellectual property – Governmental policies regarding the use of open source versus proprietary software

Table 1: Multi-level research framework for OSS domain (Niederman et al. 2006)

They emphasize that a focus should be on the organizational level from a user perspective, especially on the initial decision of a company for or against the use of OSS. The research questions of this paper contribute to the organizational level in that they show how a company can evaluate OSS and which obstacles exist specifically for OS ERP. It also takes a closer look at the software artifact (first level) by analyzing the functionality of OS ERP systems. As reported by [Gruman 2007], a broader diffusion of OS enterprise systems has not taken place yet. In any case it is difficult to obtain quantitative usage

data of this kind of software since it is not licensed through regular sales channels. Therefore, a more qualitative approach was adopted which focuses on the functionality of OS ERP systems in the business environment. After a systematic selection process (see Figure 1), three OS ERP systems were chosen and implemented using an order process scenario.

The first step was a market scan of existing OS ERP systems. For this purpose a web research on sourceforge.net, one of the largest communities hosting OSS projects, was conducted in March 2007. A search for the term 'ERP' still resulted in over 300 projects. To reduce this number, projects were excluded that did not represent ERP systems at all, for example add-ons for existing projects, translations, and abbreviations with other meaning than enterprise resource planning. Projects that were categorized as 'in planning', 'alpha' or 'beta phase', which lacked an English language version, a dedicated homepage and/or further system documentation as well as projects which represented less successful forks of existing projects, were also excluded. Forking in software engineering refers to splitting up one project in two or more follow-up projects. In addition to Sourceforge, a literature analysis was conducted involving major business magazines (e.g. CIO Magazine, CRN, eWeek) and earlier work by [Herzog 2006]. A further reduction was achieved by applying two more restrictive criteria.

The first criterion was that the license of the software had to be approved by the Open Source Initiative (OSI). Often, the term 'open source' is reduced to a marketing catchphrase without being backed-up by established definitions (e.g. [Tiemann 2007]). According to the Open Source Definition of OSI [Open Source Initiative 2007], a software license must comply with ten criteria: free redistribution, free availability and distribution of source code, derived works (modifications allowed) under the same license, integrity of the author's source code, no discrimination against persons or groups or against fields of endeavor, distribution of licenses which must not be specific to a product, must not restrict other software and need to be independent of a certain technology. Well-known OSI-approved licenses are GNU General Public License (GPL), GNU Lesser General Public License (LGPL), and the Mozilla Public License (MPL).

The second criterion was that the systems should comply with a definition of ERP. For this term, many definitions exist as well. Common to them is that an ERP system is a multi-module integrated application system consisting of modules for core business functional areas and a common database [O'Brien/Marakas 2006]. In a narrower sense ERP systems support all processes along a company's value chain, e.g. purchasing, warehousing (inventory), production (manufacturing) and sales [Jaiswal/Mital 2006, pp. 272-279]. For this purpose, a manufacturing company was chosen for the present case. Finally, the adoption of the OS ERP systems, measured by developer activity and number of downloads, was also considered. Sourceforge.net provides many statistics about their hosted software projects such as download activity, web traffic analysis, activity of source code repository and overall project activity. This information which has also been used in other research projects [FLOSSmole 2007], [Weiss 2005] led to the selection of three OS ERP projects: Opentaps, Openbravo, and ADempiere.

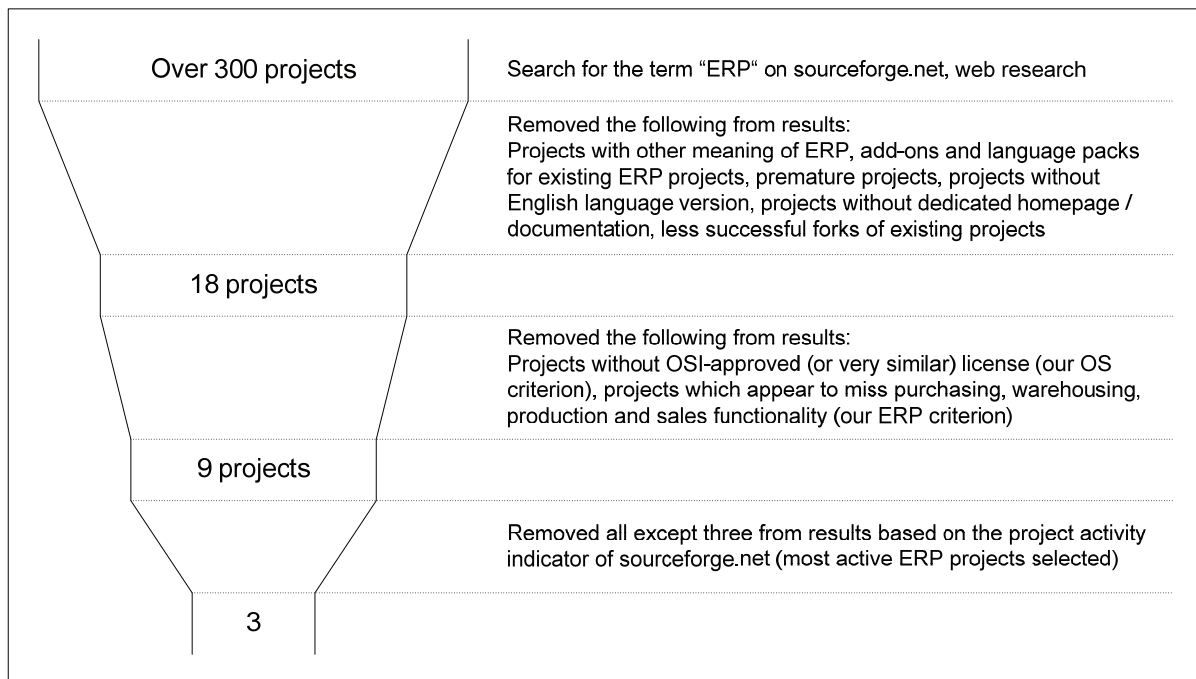


Figure 1: Methodology of narrowing search results

Table 2 shows the project characteristics of the three systems. Opentaps is based on the ‘Apache Open For Business’ framework and provides additional functionality. Developers of Openbravo used the available source code of Compiere in 2001 and have since rewritten more than 90% of the code base. The latest project, ADempiere, was forked in 2006 from Compiere. This means all systems are developed for some years already. Whereas ADempiere is developed by a community of developers the other two are mainly developed by a company. This leads to different business models and license types. ADempiere uses one of the most restrictive license types (GPL2) with a strong copyleft effect which aims at impeding the distribution of modifications under a commercial license or bundling OS with proprietary software. The community has no business model but individual developers may provide paid support if requested. Opentaps and Openbravo have service-centered business models. They sell support, trainings, consulting, certified implementations, and mutual license agreements which is also known as dual licensing (for further information see [Manenti/Comino 2007], [Välimäki 2003]).

	Opentaps 0.9.4	Openbravo 2.22	ADempiere 3.1.2-1
Homepage	http://www.opentaps.com	http://www.openbravo.com	http://adempiere.com
Project start	2005	2001	2006
License	Apache Software License 2.0 / Honest Public License (GPL-based)	Openbravo Public License (MPL-based) / Apache Software License 2.0	GPL2
Development	By company	By company	By community
Business model	Service enabler, dual licensing	Service enabler, dual licensing	-

Table 2: Selected OS ERP systems

3 Functional Analysis of OS-ERP

3.1 Setting: A Manufacturing Company

To obtain more insight in the business functionality of the three selected systems, a sample manufacturing company was used that aims at implementing an ERP system. The company is an SME which among others produces merchandising articles such as ballpoint pens. The order process which has been recognized as one of the key business processes in a company [Kritchanchai/MacCarthy 1999], [Shapiro et al. 1992] was chosen to test the functionality of the three OS ERP systems.

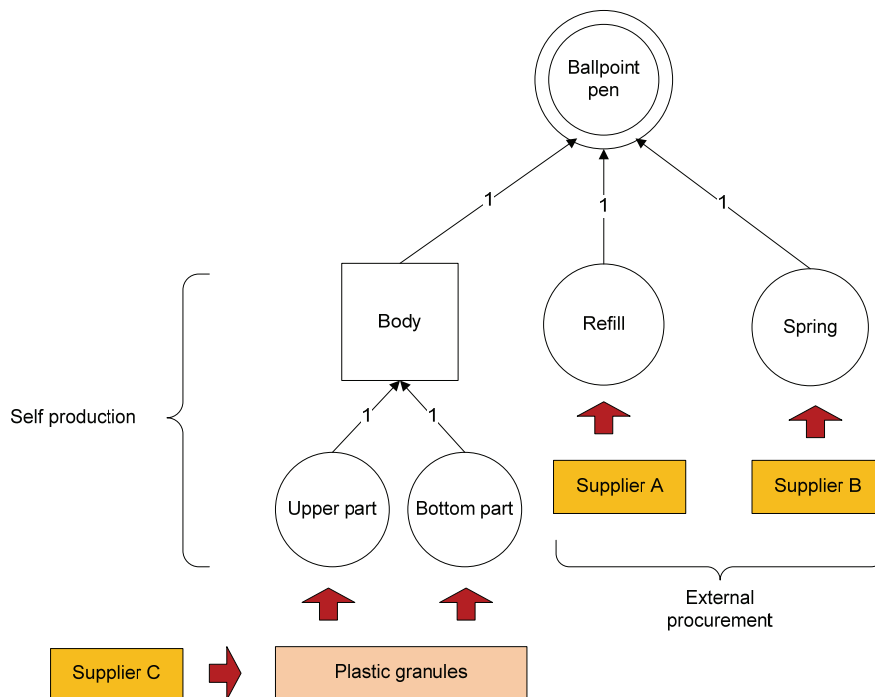


Figure 2: Ballpoint pen bill of materials

The pens produced by the company consist of a body of plastics, refill and a spring. The body is produced inhouse with a plastics injection molding machine. Refill, spring and the plastic granules for the body are procured from external suppliers. All parts and the relationship with suppliers are depicted in Figure 2. At the outset of the functional analysis all three ERP systems were installed. Then the order process described in the next chapter was implemented and tested.

3.2 Order Processing as Scenario for Comparison

Order processing in manufacturing companies consists of three steps: procurement (purchasing of materials), production and distribution.

- Starting point is a *procurement* request for a certain material, e.g. 500 kilograms of plastic granules. While processing this request the system checks the availability on stock and initiates an offer at a given supplier if necessary. The next step comprises the selection of a supplier, the calculation of order quantity and the communication of the order to the supplier. After order confirmation the order is monitored. The scheduled date of delivery is checked in regular intervals and an alert needs to be sent in case it is exceeded. Upon reception of the goods their quality is checked and they are transferred to the warehouse. At the same time this

process has to be entered into the purchase ledger and after receipt of an invoice the payment can be released.

- The *distribution* process starts with a customer request, for example for 2000 ballpoint pens. An offer is submitted and, when accepted, it will be entered as an order into the system. If the requested articles are in stock they will either be reserved or they have to be manufactured and a production order needs to be created. As soon as the ordered articles are ready for shipment they are checked for defects so quality is assured. If they pass this control the order is shipped to the customer and an invoice is created and entered into the sales ledger.
- The *production* process is triggered by the distribution process when insufficient articles are on stock. The main activities are demand planning by requirements explosion, scheduling and capacity planning, and machine assignment for the production of goods. Demand planning uses the bill of materials of the ballpoint pen to determine required raw materials, such as plastic granules, refills and springs. If these are low in stock, a procurement process for these materials is triggered.

The functional requirements for fulfilling procurement, distribution and production within the framework of the order process are summarized in the next chapter.

3.3 Results of Comparison

The results of the functional analysis are shown in Table 3 (dark grey). The production process is subdivided into requirements planning, scheduling and capacity planning, and microcontrol (light grey). The first column shows the main functions of each process and the second column refines each main function. The ratings of the functions for each system are shown in columns three to five.

		Open- taps 0.9.4	Open- bravo 2.22	ADem- piere 3.1.2-1
Procurement				
Master data management	Create/delete/edit – suppliers	●	●	●
	Create/delete/edit – materials	●	●	●
	Offer management	●	○	●
Order processing	Procurement request	○	○	●
	Supplier selection	●	●	●
	Determination of order quantity	●	●	●
	Retrieve/edit orders	●	●	●
Order monitoring	Requests	○	○	○
	Monition	○	○	○
Goods receipt	Quality control	○	○	○
	To-bin transfer	●	●	●
Distribution				
Master data management	Create/delete/edit – customer	●	●	●
	Create/delete/edit – article	●	●	●
Order acceptance	Customer request	○	○	●
	Order entry	●	●	●
	Calculation	●	●	●
	Reservation resp. creation of production order	●	◐	◐
Order control	Expediting	○	○	●
	Request processing	○	○	○
	Monition processing	○	○	○
Shipping	Quality control	○	○	○
	Define transport resources	●	●	●
Invoicing	Entry	●	●	●
	Posting	●	●	●
Production				
Requirements planning				
Master data management	Create/delete/edit bill of materials	●	◐	●
Primary demand manage- ment	Primary requirements determination	●	◐	○
	Rough-cut capacity planning	◐	◐	○
Requirements explosion	Stock determination	●	◐	○
	Gross and net requirements calculation	●	◐	○
	Batch creation	○	◐	○
	Secondary requirements calculation	●	◐	○
Scheduling and capacity planning				
Master data management	Create/delete/edit – work schedule	◐	◐	○
	Create/delete/edit – machines	◐	◐	○
Time and capacity disposi- tion	Supplement order data	◐	◐	○
	Scheduling	◐	◐	○
	Capacity planning	◐	◐	○
	Capacity leveling	◐	◐	○
Microcontrol				
Creation of machine alloca- tion schedule	Machine assignment	●	◐	○
	Time reservation	◐	◐	○

Legend:

- Part of process could be fully implemented in the system.
- ◐ Part of process could be partially implemented.
- Part of process could not be implemented, function not supported.
- ◐ Part of process could not be implemented; function appears to be available but could not be tested.

Table 3: Results of functional analysis

Functions that appear to be available but could not be tested are mainly related to missing documentation and vague error messages. In Opentaps scheduling and capacity planning is based on a calendar function. This function could not be tested due to a lack of meaningful documentation and an intuitive

approach did not lead to success. All capacity planning functions could therefore not be tested although they seemed to be available. The production part of Openbravo also lacked proper documentation, i.e. it was not possible to define which product should be planned and produced. Without a good manual, intuitive problem-solving approaches led to an error "Error: 0" which could not be resolved. Hence, the results of the functional comparison should be taken with care in this respect.

3.4 Discussion of Results

The analysis has shown that especially the support for the production process in all systems is low and not mature enough compared to procurement and distribution which are well documented and usable in all systems. It can be concluded that these systems are better suited to a retail company which does not need to produce goods. For a manufacturing company Opentaps may be a good choice because its production functionality is more usable and could be tested to a larger extent compared to the other systems. Most of the functions of requirements planning and machine assignment are supported. This is not equivalent with using Opentaps out of the box for production purposes without a deeper evaluation or customization; it just performs better than its alternatives in this functional setting. The weaknesses identified for OS ERP systems are on the one hand missing functionality in the production process and incomplete and partly outdated documentation on the other. General strengths can be seen in easy understandable and user friendly user interfaces and the free support infrastructure, specifically mailing lists and forums, where many problems could be solved. Considering these shortcomings in combination with the individual business model (see Table 2), Opentaps and Openbravo are better suited for business use than ADempiere because only the former offer services and support, and dual licensing options. Necessary customizations, add-on functionality or better documentation can be provided by a support contract with the vendor or its partners. These financial interests of the vendor also encourage the further development of the software.

On the level of the software artifact (see

Table 1) strengths and weaknesses emerged as well. Among the former are ease of installation, good user interface, support infrastructure (forums, mailing lists, documentation), and their procurement and distribution functionality. A lack of production functionality and partly missing or poor documentation can be seen as temporary weaknesses. This leads to implications on the organizational level for users of the software artifact. ERP systems are mission-critical applications. Many cases of ERP implementation failures such as FoxMeyer Drugs or Mobil Europe are well documented in the literature (e.g. [Davenport 1998]). Companies are aware of the severe impact a failed implementation may have on their business. Hence, it is not surprising that diffusion and adoption of OS ERP systems is slow and companies prefer using products from well-established vendors with a long history and a convincing track record. Furthermore, not only functional aspects should be seen when deciding for or against OS ERP systems. Potential users should be aware of the fact that evaluation criteria and advantages as well as disadvantages of OSS published in the media often reflect a general perspective. Companies need to evaluate OSS for their individual context and use cases. The freely available source code of an ERP system, for example, is not directly helpful because smaller companies usually lack skilled programmers. [Glass 2003] mentions that reading of source code can only be done by users who are programmers. This is likely with system software but not with enterprise software. However, open source code may help third-party contractors to easily customize the system. Another often mentioned advantage is the reduced overall cost due to no license fee. This is especially important and valid for private customers. In contrary, enterprise customers will have other expenses, for example, insurances or third-party contracts to indemnify against intellectual property rights violations. In the ERP field local rules and regulations have to be followed. It is not guaranteed that the community or companies behind an OS ERP project will update their software in time when rules change. Therefore a company implementing an OS solution needs to contract with a service provider or staff a good IT department by itself which results in higher costs.

As the implementation of OS ERP systems is expected only to generate marginal savings, a company should instead focus on other benefits such as open standards, flexibility, and freely available source

code. Companies with specific requirements could base their solution on an OS ERP system and save more work instead of programming everything from scratch. For instance, this was one of the reasons why Mango Network decided to implement Compiere [Santodus 2006]. In general, there is no single answer to why a company should consider using an OS ERP. Small companies with limited functional requirements and an open-minded IT department which is able to do smaller customizations should consider OS ERP systems because their provided functionality might be sufficient. Companies with heavy customizing needs should consider OS ERP as well so they do not need to develop everything from scratch. The business models of companies developing these systems are only little different from those of commercial products as they heavily rely on support and service. So it may be a matter of time until the big players in the OS ERP market may compete with commercial vendors targeted to SME.

4 Conclusions

This research aimed to provide an overview of current OS ERP products which are still niche products for early adopters. To provide more insights into the functionality of these products, a scenario of a manufacturing company has been developed. Using a typical order process of a manufacturing company which includes procurement, production and distribution activities, three OS ERP products were evaluated. The functional analysis has shown that most parts of the procurement and distribution process were supported, but only a limited part of the production process. An explanation may be the historical development of these systems since early ERP systems in the commercial sector have been evolved from materials requirements planning (MRP I) and manufacturing resource planning (MRP II). Additional functionality in other areas, such as distribution and accounting, was developed around the MRP core [Olson 2004, p. 12]. Contrary, the OS ERP systems emerged since 2000. Their goal was to develop software supporting inventory management and functions for the retail industry and many success stories exist for this industry. Later their functionality was extended towards the production sector which may explain why this part is less mature compared to commercial alternatives. As maturity comes with time, functional improvements may be expected in the forthcoming years. Limitations of this research are the representativeness of three OS ERP systems for the whole market and the validity of results in time. Although the three tested products are dominant representatives in the OS ERP market, they are not representative for the entire OS ERP market. Consequently, the results from the comparison are only valid for the software versions which have been tested. Typically, new versions of OS emerge rapidly and may include changed or new functionality.

In summary, research in the area of OS enterprise systems has been done only marginally. Therefore, combined research of the OS phenomenon is suggested with an enterprise perspective. At least three future research questions have surfaced in this research: (1) In what respect are OS ERP and other OS enterprise systems different from Business Intelligence (BI) or Customer Relationship Management (CRM) systems and which impact does this have on diffusion and adoption? (2) Is the OS paradigm and development model well-suited to design and develop standardized business solutions or are these solutions mere frameworks which need so much customization that they can be seen as individual software? (3) How can enterprises determine when to implement OS enterprise systems compared to COTS? The evaluation methodologies also need to take into account specifics such as new development paradigms, varied business models and many license types with more or less restrictive implications on software use.

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