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WHICH TYPE OF SOFTWARE MODEL IS FIRST CHOICE? AN AHP-BASED COMPARISON OF TRADITIONAL, OPEN-SOURCE, AND ON-DEMAND OFFICE SUITES ON THE FULFILLMENT OF EVALUATION CRITERIA

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Abstract

Until recently, organizations planning to acquire enterprise application software (EAS) have had no choice but to adopt proprietary, on-premises software. With the advent of open-source and on-demand solutions in different EAS markets, new models for developing and distributing software have entered the stage providing IT purchasing managers with more degrees of freedom in EAS selection. While there is a large body of research in EAS selection, existing research has so far neglected to integrate these new options into their investigations. Our empirical study addresses this research gap by comparing how IS purchasing managers evaluate the relative fulfillment of critical selection criteria by traditional, open-source, and on-demand Office suites. Based on an analytic hierarchy process model (AHP) that was empirically tested with a random sample of 254 IS (purchasing) managers, we found, overall, that open-source solutions are neck and neck with traditional Office suites that both outrivaled the on-demand software model. Interestingly, the on-demand solution was first choice based on the fulfillment of implementation criteria, while the open-source solution was the dominant alternative in the fulfillment of package attributes. Finally, IS managers rated functionality and support as most important evaluation criteria in Office suite selection, while cost ranked only fifth.

Keywords: Office suite, software selection, evaluation criteria, enterprise application systems, analytic hierarchy process

1 INTRODUCTION

Until a few years ago, IS managers have had no choice but to evaluate and select proprietary and on-premises enterprise application software (EAS). Since no serious alternatives have been available on EAS markets, many traditional EAS providers such as Microsoft, SAP or Oracle could earn a fortune with this traditional way of developing and distributing application software. However, with the emergence of successful open-source and on-demand solutions in different EAS markets in the last couple of years, new models for developing and distributing software have evolved providing IS managers new options in EAS selection. In the Office suite market, for example, open-source Office suites such as OpenOffice.org or KOffice and on-demand (i.e., Software-as-a-Service (SaaS)-based) solutions such as Google Apps (Docs & Spreadhseets), Zoho or ThinkFree Apps are already affecting the bottom-line of traditional incumbents such as Microsoft (MS Office). For the first quarter in 2009, Microsoft posted the first decline in revenues in its 23-year history with its Business Division (where MS Office represents the bulk) having its revenue fall by 5% (Wingfiled, 2009). According to analysts, the drop in revenues is not only attributable to a general pullback in consumer spending in the wake of the financial crisis, but also due to a barrage of new threats such as open-source and SaaS that constantly make inroads into the Office market (Knowledge@Wharton, 2007).

Despite the growing diffusion of alternative EAS solutions, prospective buyers in companies are still puzzled about how to evaluate these new alternatives relative to traditional options and what option is superior in the fulfilment of key selection criteria. However, while there is an abundance of practitioner-oriented and research literature on the selection of proprietary, on-premises EAS, existing research still lacks the investigation of how these new options (i.e., on-premise/open-source and on-demand/closed-source) to traditional EAS (i.e., on-premise/closed-source) affect the evaluation and selection of EAS. In this study, we attempt to address this research gap by examining how traditional, open-source, and on-demand EAS compare in the fulfilment of classical evaluation criteria based on the example of Office suites. More specifically, we address the following research questions:

1. What type of software model (on-premise, closed-source vs. on-premise, open-source vs. on-demand, closed-source) is comparatively superior in the fulfilment of key evaluation criteria in Office suite selection from the perspective of IS (purchasing) managers?
2. What are strengths and weak spots of the three software models and what can providers do to address them?

The remainder of the paper is organized as follows. In the next section, we discuss the relevant literature on EAS selection in general and on Office suite selection in particular. In section 3, we describe the characteristics of most important alternatives emerging in the field of Office suites. In section 4, we describe our research methodology used in this study by presenting an analytic hierarchy process (AHP)-based model for the evaluation and selection of Office suites. Furthermore, we present the procedures of an empirical study where we applied our AHP-based model involving 254 IS (purchasing) managers. In section 5, we present the results of our empirical analyses. Finally, we conclude with a discussion of theoretical and practical implications of our findings, as well as limitations and future research opportunities in section 6.

2 PRIOR RESEARCH IN THE EVALUATION OF ENTERPRISE APPLICATION SYSTEMS AND OFFICE SUITES

The acquisition of package EAS (such as ERP, CRM, or Office suites) by companies often involves making trade-offs between a variety of attributes like cost, functionality, and ease of customisation. Many practitioner-oriented and academic studies in IS research have investigated the relative

importance of these evaluation attributes for different application types. Jadhav & Sonar (2009) provide a comprehensive literature review on the evaluation and selection of EAS packages. They found that the majority of empirical studies investigate software packages based on criteria that are related to the software package itself (e.g., functionality, ease of use, and cost) and to the implementation (e.g., support, ease of customization, and ease of implementation) of the software package (e.g., Keil & Tiwana, 2006). Research on critical evaluation factors in Office system selection is embedded into the stream of office automation literature that goes back to the late 70s and early 80s (e.g., Hirschheim, 1985). In their seminal study, Beck and Lin (1981) proposed a hierarchical system selection methodology for automated Office systems and found in a case study that software capabilities (such as functionality and reliability) and vendor support were the most important factors to consider, while ease of implementation and compatibility issues were less important (Beck & Lin, 1981). After these findings were largely confirmed by empirical follow-up studies (e.g., Sassone, 1987), more recent literature have embraced elaborate research methodologies (such as fuzzy-based approaches or analytic hierarchy process models) to yield more specific answers for the evaluation and selection of Office systems. Anderson and Chen (1997), for example, have found that ease of use have become much more important over time due to new hardware and software capabilities, while functionality have remained the dominant factor in Office suite selection (Anderson & Chen, 1997). Noble (1995) focused his research more on implementation strategies for Office systems and claimed that ease of implementation and customisation were indeed crucial evaluation factors prior to purchasing and implementing Office systems, as otherwise these systems would not be accepted by end-users (Noble, 1995).

Consistent with the literature on EAS selection, seven factors of the following two categories were the most dominant attributes examined in Office suite evaluation[1]:

1. Software package attributes: cost, functionality, reliability, and ease of use
2. Implementation attributes: ease of customization, ease of implementation and support

Cost is a common factor influencing the purchaser to choose the software. It is simply the expenditure associated with Office suites and includes product/license, training, maintenance and software subscription costs (Chou, 2008). Technically, these costs can be grouped under two major criteria, namely, capital expenditures and operating expenditures. Capital expenditures are non-recurring costs involved in setting up the Office suite, while operating expenditures are recurring costs involved in operating the Office suite. *Functionality* refers to those features that the Office suite performs and, generally, to how well the software can meet the user's needs and requirements. Thus, functionality is usually one of the most important selection criteria considered when selecting software packages, such as in (Lai et al., 1999; Wei et al., 2005). The typical core components of Office suites are word processing, spreadsheet analysis, and presentation programs that are often complemented by communication and groupware functionalities. Brown & Stephenson (1981) suggest that one of the advantages of buying packaged software is that it represents a superior product relative to what might be developed in-house. Thus, what drives many packaged software purchases is the desire to have a higher-quality, more robust and *reliable* piece of software (Brown & Stephenson, 1981). Wei et al. (2005) lists reliability as one of the most important objectives that every software package should satisfy. Chau (1995) stresses the importance of '*ease of use/user-friendliness*' as one of four technical factors that should be considered in selecting packaged software (Chau, 1995). Montazemi et al. (1996) stress that the software package should be easy and straightforward to use, since the product shouldn't be too complex or sophisticated for an average user, as the efficiency of end users directly affects the efficiency of the organization.

[1] In accordance with prior studies, we do not claim that this list of selection criteria is exhaustive or exclusive, but rather that it represents an established subset of the most crucial factors in EAS/Office suite selection.

Bryce & Bryce (1987) suggest that software buyers usually consider what changes to the system are required in the future in order to meet requirements (Bryce & Bryce, 1987). Borenstein & Betencourt (2005) note that flexibility is an important consideration in selecting packaged software. By this, they mean whether the package can be *easily adapted and customized* (Borenstein & Betencourt, 2005). Goldenberg (1991) also emphasizes the importance of being able to customize the software package. Since different organizations need different software, they need to adapt the available software in the market for their own use (Goldenberg, 1991). Pivnicny & Carmody (1989) list '*ease of implementation*' as one of nine criteria for evaluating packaged software. This criterion is usually highly ranked because of the extensive changes in policies and procedures required to implement new applications (Pivnicny & Carmody, 1989). Romanow et al. (1998) note that the time and cost required to implement a software package often surface as a key factor in a company's packaged software selection process (Romanow et al., 1998). In addition, the application components of the software package should dovetail easily with other applications of a company's application architecture and provide seamless data flow among those applications. Finally, the quality of *support* provided and its characteristics are of major importance in the selection of software. It is particularly critical for the successful installation and maintenance of the software. Brown & Stephenson (1981) list 'supplier support' as the first of six major factors that should be considered in evaluating packaged software. Keller (1994) even emphasizes the importance of vendor stability over functionality, stating that "it is not so important that a company can meet a functional specification as it is that it has a viable plan to be in business in 5 years". Important indicators of reliable and resourceful support include a consulting and hot-line service, the quality and flexibility of training, and the presence of an active technical support program and group (Keller, 1994).

As shown above, a large body of research in software package evaluation has evolved over the last decades. However, existing studies all refer either to traditional software models (i.e. closed-source and on-premise) or focus solely on the evaluation of open-source (e.g., Al-Qutaish et al., 2009)or on on-demand software models (e.g., Godse & Mulik, 2009). The current body of knowledge, however, lacks an empirical analysis that compares the relative performance of traditional, open-source and on-demand software delivery options regarding the fulfilment of key evaluation criteria in a single model.

3 EVALUATING TRADITIONAL, OPEN-SOURCE AND ON-DEMAND OFFICE SUITES

Open-source can be seen as a movement where communities of software developers, bug testers, patch submitters, and end-users collectively develop software in public bazaar-like spaces (Raymond, 2001). These spaces are distributed, delegated, and loosely coupled communities kept together by strong common values. Open-source software (OSS) refers to software that is distributed under an Open Source Initiative (OSI) license that guarantees the buyer the right to read, redistribute, modify, and use the software freely (Ljungberg, 2000). By contrast, proprietary software usually belongs to a specific individual or company and is often protected by a patent or copyright law, while its source code is kept closed. Although Titterton (2003) states that 70% of business users are motivated primarily by *cost* savings to adopt open-source EAS (Titteron, 2003), OSS is not necessarily free of charge. An open-source distributor may charge for services related to distributing, implementing, or otherwise supporting the software, or there may be charges for proprietary extensions built on top of OSS. In terms of *functionality*, open-source EAS are said to provide functionality that proprietary packaged EAS often does not have (Ljungberg, 2000). Firms with specialized requirements can benefit from access to the software's source code, and thus may modify and augment the functionality of the application system according to their specific needs. The *reliability* of OSS is often discussed in light of software code quality. OS advocates emphasize the superior quality of OSS due to the possibility of massive code-level peer reviews, and developers' more intrinsic motivation and higher sense of ownership in the OS community (Fitzgerald, 2006). Empirical studies have found, however, that testability, simplicity, readability, and self-descriptiveness as indicators of OSS structural code quality

provided results lower than the quality implied by industrial standards (e.g., Stamelos et al., 2002). Opinions are also divided over the criterion '*ease of use*'. Since OSS developers are known to emphasize function over form, most OSS projects are driven by the functional requirements of developers who tend to look at usability from their own perspectives. In contrast, researchers arguing in favour of OSS claim that it has considerably progressed from these early, amateurish stages (Olbrich & Koch, 2006). According to case studies in the public sector, using OSS enables organizations to provide tailored applications and thus *high ease of customization* instead of the limited choices that proprietary software packages may offer (Waring & Maddocks, 2005). Having full access to the EAS source code should make upgrades relatively easy and affordable (Serrano & Sarriegi, 2006). On the other hand, practitioners report that EAS' ease of customization is often hampered by the lack of in-house expertise, which is necessary to write fresh code to make an open-source program work (Bartholomew, 2008). Proponents of open-source EAS argue that OSS is based on open standard interfaces that allow software to be more *easily implemented and integrated* into an existing application landscape. Goode (2005), on the other hand, observed that OS-adopting firms see the adoption of and migration towards OSS as a significant undertaking, since open standard interfaces often do not support interoperability with legacy systems (Goode, 2005). Another potential rub for organisations looking to deploy open-source applications lies in the *support* that is provided around the EAS. Many organisations view open-source applications as risky, with little or no assurance that the software will be supported in the present and future. However, open-source advocates claim that there is a spectrum of support models available for open-source EAS with considerable momentum behind them: Do it yourself, join a consortium, get consultancy or direct vendor support (Rahtz & Metcalfe, 2004).

On-demand software delivery models are another major trend in the provision of EAS. They are known since the late 1990s and have come in many forms and varieties such as Application Service Providing (ASP) or Business Service Providing (BSP). The common denominator of all these concepts is that this kind of demand-driven application sourcing model provides network-based access for companies to EAS functionality in the form of software services (Kern et al., 2002). While discussions on ASP-based outsourcing have become rather silent in recent IS research and management literature, Software-as-a-Service (SaaS) has caught the attention of IS executives because it is believed to become a fundamental pillar of revenues for IT vendors in the next couple of years. SaaS is said to be superior to traditional on-premises software models in the way that it helps companies to focus on core competencies, to reduce vendor lock-in and to increase flexibility of choosing among the latest (state-of-the-art) technologies (Kern et al., 2002). In addition, IT experts also claim that software engineered for SaaS will have dramatically lower *cost* structures than traditional software. Although having a lower level of *functionality*, the simplicity of purpose and *ease-of-use* would allow SaaS to compete effectively in EAS markets (Chou, 2008). The biggest advantage of on-demand solutions is seen in the fact that they are more approachable than their on-premises counterparts. SaaS-based solutions do not require tedious software installations on users' computers and offer quick time-to-value. According to practitioner-oriented publications, customers can *effectively implement* and use SaaS in a substantial way within days and weeks of purchase compared to the months or years usually required for traditional on-premise software (Chou, 2008). This is due to the fact that SaaS vendors are responsible for making the pieces of the entire application stack work together and that they know configuration and usage patterns already. *Support* services are also considered more effective, since software vendors are much more familiar with the technical details of the installation than in a traditional on-premise situation where customers have to deal with installation issues on a daily basis. Countering these advantages are the acknowledged risks of *reliability* (how can be ensured that the access to the applications is stable and high-performing?), security (how can data privacy be guaranteed in line with regulations?), and the low level of control over *feature customizations* when sourcing EAS via a SaaS interface (Dubey & Wagle, 2007).

As shown in the preceding paragraphs, existing discussions on the relative advantage of the different software models stop at a qualitative level. What is still missing so far is a quantitative and empirical

analysis of traditional and new software models on the fulfillment of key evaluation criteria in the selection of EAS in general and of Office suites in particular.

4 EMPIRICAL METHODS

4.1 The Analytic Hierarchy Process (AHP)

The AHP, developed by Saaty, is a method designed to solve complex multi-criteria decision problems (Saaty, 1980) and is aimed at integrating different measures into a single overall score for ranking decision alternatives. AHP has been applied to a wide variety of decisions such as vendor selection, IS project selection, and software selection (e.g., Lai et al., 1999). Although there have been a large number of research studies on using AHP for software selection, each of the studies has focused on software with a different nature and function, such as antivirus and content filtering software, executive IS, simulation software, expert systems, multimedia authoring systems, logistics IS and office and collaboration software (Jadhav & Sonar, 2009). Since existing AHP-models on Office suites do not fully cover the technological developments that have taken place in recent times, it is necessary to design and develop an updated AHP model to help IS practitioners select an Office suite that meets the requirements of their organization. In order to make a decision in an organized way based on the AHP-methodology, Saaty suggests following 4 steps to generate priorities and corresponding local and global weights of attributes (Saaty, 1980). (1) Define the problem and determine the kind of knowledge sought. (2) Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels to the lowest level (which usually is a set of the alternatives). (3) Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it. (4) Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Then for each element in the level below, add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained. Based on a comprehensive literature review (see section 2), step (1) and (2) were addressed by deriving the decision hierarchy as shown in Figure 1.

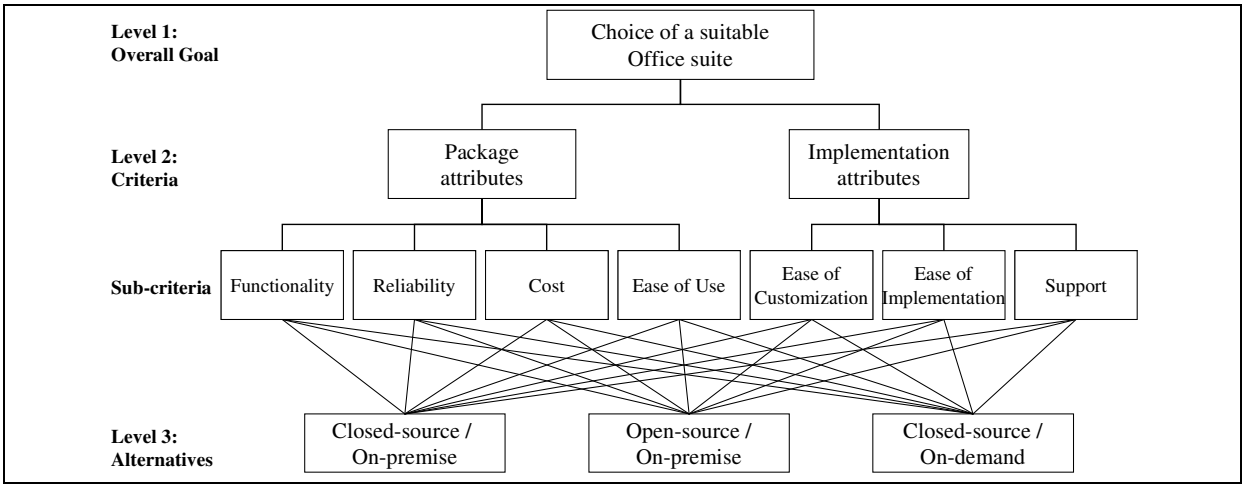

Figure 1. The hierarchy of the AHP model for selecting Office suites

To address steps (3) and (4), the attributes (or sub-criteria) of Office suites are compared in terms of their importance within a given category by a selected sample of decision-makers (which will be described in section 4.2). Several ways of making the comparisons exist. The most common one requires from the interviewed group to provide a rate, w_{XY}, regarding the importance of an attribute, X,

in comparison to the importance of another attribute of the same category, Y (see pairwise comparison scale for AHP preferences in Table 1).

Verbal Judgement	Numerical rating
X is equally preferred to Y	1
X is equally to moderately preferred over Y	2
X is moderately preferred over Y	3
X is moderately to strongly preferred over Y	4
X is strongly preferred over Y	5
X is strongly to very strongly preferred over Y	6
X is very strongly preferred over Y	7
X is very strongly to extremely preferred over Y	8
X is extremely preferred over Y	9

Table 1. Pairwise comparison judgements between element X and element Y

Then, the rate of the importance of attribute Y over X, the reciprocal comparison, is deduced from the previous (and is given by $1/w_{XY}$). By assigning numerical ratings to each comparison, a matrix of weights can be derived reflecting the importance of each attribute with respect to each other. By using this procedure, there are no symmetric inconsistencies (the importance of Y over X will always be consistent with the importance of X over Y). However, the transitive property may not be hold (i.e., the degree of importance of X over Y does not have to be consistent with the importance of X over Z and Z over Y). Therefore, the possibility of potential inconsistencies has to be analysed by using a normalised consistency ratio (CR). In this context, the threshold value of 0.1 is an accepted upper limit for CR (Saaty, 1980). To determine *local weights* for the alternative sub-criteria with respect to the upper criteria (e.g., package attributes), normalized matrices are calculated based on the values of the pairwise comparisons (Saaty, 1980). Local weights are then derived by calculating the average value in each row of each normalized matrix (Lai et al., 1999). *Absolute weights* are calculated by multiplying the weight of the upper criteria by the local weights (Saaty, 1980). Finally, once all the relative weights have been calculated, a *composite weight*, c_d, for each decision alternative (e.g., the different types of Office suites) is determined. This is accomplished by aggregating the weights over the hierarchy for each decision choice. To do this, the weights along the path from the top of the hierarchy down to a decision choice are multiplied and then added across all the different pathways to that decision choice.

4.2 An empirical study using the AHP model

In order to validate our AHP-based model, we conducted an online-survey during June 2009 using Expert Choice's Decision Portal among EAS-adopting companies. All German companies in manufacturing, wholesale/retail trade, TIME industries, financial services, construction and real estate, public and healthcare sector, logistics and electricity/gas/water supply were chosen as population of this study, since company size restrictions are not necessary, because Office suites are implemented and used in companies of all sizes in the selected industries. For our online survey, a random sample of IS managers in 1.500 German companies was drawn from Hoppenstedt's firm database based on the population characteristics above and invited by mail and e-mail to participate. In our cover letters, we explicitly addressed those IS managers that had the qualification and mandate in an organization to purchase EAS, as they were the most adequate respondents for our study. The survey underwent both a pretest and pilot phase. Content and face validity of our survey instrument was ensured by asking 10 IT/IS practitioners and 3 academic experts to go through the pairwise comparisons and then provide feedback on comprehension and usability.

Category *(Measurement)*		**Category** *(Measurement)*	
Number of Employees	*Composition (%)*	*Annual Revenue (€ million)*	*Composition (%)*
< 10	30.4	< 1	35.1
10 – 49	35.1	1 – 4	27.2
50 – 100	16.2	5 – 14	24.1
> 100	18.3	> 15	13.6
Intensity of usage of … (5-point Likert scale, mean (stdv))		*Respondent Title*	*Composition (%)*
MS Office	4.3 (*0.56*)	IT purchasing manager	85.7
OpenSource.org	3.8 (*0.95*)	IT manager	11.3
Google Apps (Docs & Spreadsheets)	4.0 (*0.81*)	Other managers and n/a	3.0

Table 2. Sample characteristics (N=254)

During the online survey, the participants were asked to first compare the given alternatives with respect to each sub-criterion. As for the alternatives, we chose to use the three most prominent representatives for each type of software model, since we assumed that participants had the highest level of familiarity with these types of Office suites: MS Office for on-premise, closed-source; OpenOffice.org for on-premise, open-source; and Google Apps ("Docs & Spreadsheets") for on-demand, closed-source. In the second step, participants had to compare the sub-criteria on a pairwise basis with respect to the upper criteria. Finally, the relative importance of the upper criteria, in our case the categories 'package attributes' and 'implementation attributes', had to be compared among themselves. While making the comparisons, participants had the opportunity to comment on each comparison by entering qualitative statements into text boxes. We received 254 completed sets of responses, resulting in a response rate of 17%. Our sample included firms with the following industry split: manufacturing (22%), wholesale and retail trade (21%), financial intermediation (19%), TIME industries (14%), construction and real estate (11%), logistics (7%), public and healthcare sector (4%), and electricity/gas/water supply (2%). Table 2 shows the sample characteristics of our empirical study. More than 85 percent of the respondents stated to be in charge of procuring IT/IS and around 10 percent indicated that they were general IT managers. On average, they had 12.8 years of experience in the management of information systems, and had previously been involved in making EAS selection decisions for around 28 software packages. They also indicated on a 5-point Likert scale that they have intensively used the different types of Office suites investigated in our study in the past.

5 STATISTICAL ANALYSES AND RESULTS

5.1 Evaluation results

The most appropriate Office suite software that should be selected according to IS managers is MS Office and OpenSource.org. Based on the aggregate results calculated by Expert Choice, both types of software models were neck and neck regarding the overall composite weight (c_d=*0.34*). Google Apps was third with a priority value of *0.32*. The overall consistency of the input judgements at all levels was within the acceptable ratio of 0.1 (*CR=0.04*).

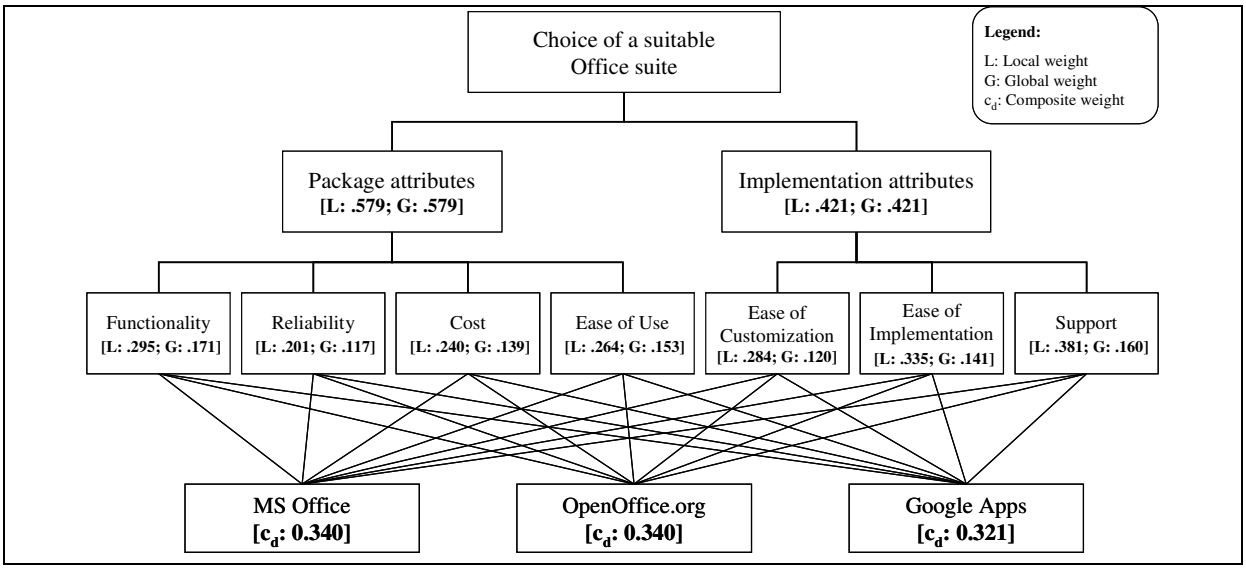

Figure 2. Evaluation results of AHP model for selecting Office suites (n=254, CR=0.04)

As shown in Figure 2, package attributes (*0.579*) were valued higher than implementation attributes (*0.421*) in the selection of Office suites. More specifically, functionality was the most critical package attribute with a local weight of *0.295* followed by ease of use (*0.264*), cost (*0.240*) and reliability (*0.201*). Support was the most critical implementation attribute with a local weight of *0.381* followed by ease of implementation (*0.335*) and ease of customization (*0.284*). For a global weights-based ranking of evaluation criteria, we found that functionality was the most valued sub-criteria with a global weight of 0.171 followed by support (*0.160*), ease of use (*0.153*), and ease of implementation (*0.141*). Interestingly, the factor 'cost' (*0.139*) was ranked fifth, only followed by ease of customization (*0.120*) and reliability (*0.117*). When evaluating which software model was superior in fulfilling the attributes (see Table 3), we found that OpenOffice.org was the dominant alternative in fulfilling package attributes, while Google Apps was superior in fulfilling implementation attributes. Analyzing the strengths and weak spots of each alternative, we found that MS Office comparatively excelled in the fulfilment of the evaluation criteria 'functionality', 'ease of use', and 'support', while it was considerably lagging behind on-demand and open-source alternatives with respect to 'cost', 'reliability', and 'ease of implementation'. A qualitative comment of one participant fittingly summarized the results: "*MS Office can look back on a long tradition of providing Office functionality and constantly honing the usability of its programs. However, when it comes to stability, cost, and flexibility, it is outrivaled by alternative solutions*".

Selection criteria	MS Office	OpenOffice.org	Google Apps
Package attributes	.343 *(2)*	.353 *(1)*	.304 *(3)*
• Functionality	.427 *(1)*	.310 *(2)*	.263 *(3)*
• Reliability	.257 *(3)*	.384 *(1)*	.359 *(2)*
• Ease of use	.397 *(1)*	.321 *(2)*	.282 *(3)*
• Cost	.261 *(3)*	.410 *(1)*	.329 *(2)*
Implementation attributes	.334 *(2)*	.323 *(3)*	.343 *(1)*
• Ease of customization	.330 *(2)*	.389 *(1)*	.281 *(3)*
• Ease of implementation	.263 *(3)*	.321 *(2)*	.416 *(1)*
• Support	.397 *(1)*	.274 *(3)*	.329 *(2)*

Table 3. Aggregated evaluation criteria weights (%), ranks in brackets (n=254)

OpenOffice.org was the dominant alternative in fulfilling the factors 'reliability', 'cost', and 'ease of customization', while major pain points were 'ease of use', 'functionality' and particularly 'support'.

An insightful comment was put forth by another participant: "*The big advantage of open-source Office suites for our organization is that our in-house developers can easily adjust the basic functionalities to our specific company requirements and put these customizations up for discussion in the OS community*". Finally, Google Apps (Docs & Spreadsheets) major sore points in the fulfilment of evaluation criteria were the factors 'functionality', 'ease of use', and 'ease of customization', while its single outstanding strength was 'ease of implementation'. In this context, an interesting comment of a respondent to the on-demand provision of Office suites was that "[…] *on-demand solutions such as Google Docs & Spreadsheets prevent us from having the hassle to install and update the software on a regular basis. In addition, it helps us having access to latest software releases*".

5.2 Sensitivity analyses

After evaluating the judgments about the relative importance of evaluation criteria, sub-criteria and alternatives, Expert Choice's sensitivity graphs were used to test possible changes in the decision.

	Criteria weights (%)		Global scores (%)		
Scenario	Package attributes	Implementation attributes	MS Office	OpenOffce.org	Google Apps
1 (actual)	57.9	42.1	34.0	34.0	32.0
2	90.0	10.0	34.2	35.0	30.8
3	60.0	40.0	34.0	34.1	32.0
4	50.0	50.0	33.9	33.8	32.4
5	20.0	80.0	33.6	32.9	33.6
6	10.0	90.0	33.5	32.6	33.9

Table 4. Sensitivity analysis based on 6 scenarios (dominant alternative is shaded)

Table 4 indicates that the priority of the package attributes is adjusted gradually from *0.90* downwards starting from scenario 2. In scenarios 2 and 3, OpenOffice.org is first choice in Office suite selection. When the priority of the package attributes is lowered to *0.578*, however, the optimal choice changes from OpenOffice.org to MS Office. At a priority level for package attributes lower than *0.176*, Google Apps becomes the sole dominant alternative in Office suite selection.

6 DISCUSSION

6.1 Major Findings and Contributions

This study is the first study to examine how new emerging options (i.e., open-source and on-demand) for the provision of EAS compare with traditional software models in the fulfilment of evaluation criteria in EAS selection. It updates and extends the existing body of knowledge in Office suite selection by investigating the relative superiority of the different software models in fulfilling a validated set of evaluation criteria. Referring back to our research questions posed at the outset, we can derive several implications for researchers and practitioners.

First, we could partly validate previous results in automated office systems selection research that functionality and ease of use are the most crucial selection criteria. Additionally we could confirm that implementation attributes such as ease of implementation and customization are of less concern in the eyes of IS managers when evaluating Office systems, which may be due to the fact that they usually do not require lots of sophisticated implementation and adaptation efforts. However, we could also show that evaluation factors that have been attached a lower level of importance in the past have become much more important in Office suite selection and vice versa. More specifically, 'support' has

been a less important evaluation factor in previous studies (Montazemi et al., 1996), while IS managers have put much more emphasis on 'reliability' than could be found in this study (Keil & Tiwana, 2005). One possible explanation could be that by considering relevant new options for the provision of Office suites such as open-source, they have shifted their attention and preferences towards factors that are more important for the evaluation of new software models. For example, since open-source Office suites are performing worse than traditional and on-demand software models in providing high-quality support, IS managers may want to put relatively more emphasis on support while scrutinizing different alternatives.

Second, we found that the traditional and the open-source alternatives are the leading software models to fulfil the evaluation criteria of IS managers. More specifically, we could show that OpenOffice.org is the dominant alternative in fulfilling package attributes mainly due to lower cost and better reliability, while Google Apps (Docs & Spreadsheets) is superior in fulfilling implementation attributes mainly due to its high ease of implementation. Unexpectedly, MS Office does not play a dominant role in fulfilling package and implementation attributes. However, due to its overall performance, it outrivals the on-demand option in fulfilling package attributes and the open-source alternative in fulfilling implementation attributes. These results provide major insights into how IS managers of software adopting companies value the relative performance of each software model. In this context, IS managers responsible for selecting Office suites can learn from this study what a representative sample of IS (purchasing) managers considers to be the most important selection criteria in Office suite selection. In some cases, managers spend considerable time constructing an exhaustive list of selection criteria, but put relatively little time considering what weights to assign to the various criteria. When this occurs, important considerations on the functionality, support or ease-of-use of a system tend to be assigned less weight than they deserve. In this regard, the empirically derived weights of the selection criteria of this study can be used as a benchmark or guideline to which IS managers can compare their own thinking.

Finally, based on our sensitivity analyses, we can derive recommendations for Office suite providers how to address potential weak spots in their software offerings. If traditional software products want to keep their dominant role in Office markets, they can address pricing schemes, but also reliability and ease of implementation of their software. Microsoft has recently announced to offer a complementary on-demand Office solution called MS Office Live which may seem as a first step to go into this direction. Open-source Office suites are still faring relatively poorly in providing professional software support. In order to address these support issues, open-source project administrators should think about different options to provide support that is more professional than in the past. According to our findings, on-demand products are strong in implementation, since they spare user companies from installation intricacies and hassles. However, if they want to be a serious contender to traditional and open-source products, they have to improve on the fulfilment of package attributes. According to a considerable number of qualitative comments in this study, on-demand Office suites have offered so far only lightweight functionality and a lower level of usability that cannot compete with on-premise installations in an organizational setting. If they want to gain a stronger foothold in business markets, they obviously have to increase their functionality and ease-of-use.

6.2 Limitations and Future Research

The research model was limited to the investigation of a special type of EAS, namely Office suites. Although Office suites are a widely used type of enterprise software, it is a highly standardized application type that does not require high levels of customization such as ERP or CRM systems. Thus, we must be careful not to generalize our results to EAS beyond Office systems. Future studies should investigate application types that need higher levels of adaptation such as ERP systems. For the sake of clarity, we restricted our analysis to pure forms of software models opposing each other at the extremes of different continuums (i.e., closed-source vs. open-source; on-premise vs. on-demand). Future research should examine how hybrid forms of software models (e.g., open-source core

functionality with proprietary modules on top) may 'blur' the clear lines that we have drawn with our results. Finally, due to the high number of evaluation criteria investigated in this study, we restricted our analysis to one level of sub-criteria for package and implementation attributes. More concrete results could be gathered, if another level of sub-criteria is entered into the AHP model. For example, the factor 'cost' could be split up into acquisition, maintenance, conversion, and ownership cost items.

In conclusion, new emerging alternatives for the provision of Office suites, i.e. in particular open-source options, have evolved to a serious contender to traditional (closed-source and on-premises) Office suites that are convincing enough for IS managers to challenge the dominant position of traditional players. However, the question still remains whether these new emerging options will be strong enough to topple the giant or whether traditional providers will be able to fend off the attacks.

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