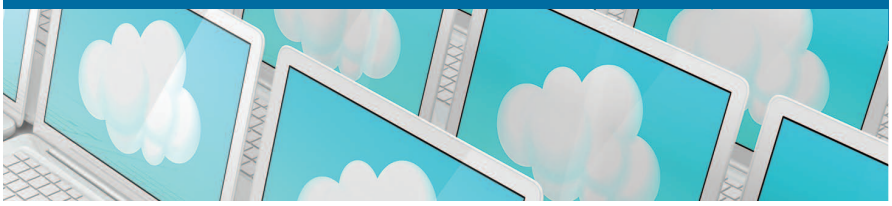
Business Application Acquisition: On-Premise or SaaS-Based Solutions?

Stamatia Bibi, Aristotle University

Dimitrios Katsaros and Panayiotis Bozanis, University of Thessaly

// A case study illustrates a method for analyzing the business context of migrating applications to the cloud and a decision model for comparing total ownership costs. //



CLOUD COMPUTING REPRESENTS a service-oriented shift in the way software applications are designed, built, and delivered. The term *cloud computing*, which became popular in early 2007, refers to virtual servers, distributed hosting in large datacenters, and shared resources available over the Internet.[1] These technologies let business users contract for software, middleware, and infrastucture.[2] Cloud providers offer three major system types: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). In SaaS, consumers pay for a software subscription and move all or part of their data and the managing code on remote servers. An example of SaaS is Google Docs, which gives consumers access via a thin client—that is, a Web browser. In PaaS, software developers build code that executes on a PaaS provider's platform instead of on their own enterprise platform. Google App Engine is a characteristic example. Finally, IaaS delivers virtual machines (VMs) on demand to provide scalability to running software. Amazon's Elastic Compute Cloud (EC2) implements this type of service.

Currently, the cloud suffers from several weaknesses—most significantly, security and privacy,[3] interoperability between cloud platforms, and continuous service availability and viability in cases of cloud providers going out of business. We don't expect all these problems to be solved in a way that suits all business needs—at least not very soon. However, several efforts toward their resolution indicate that the cloud will earn a significant share of the IT industry.[4] For instance, Salesforce.com created its AppExchange as an open integration platform that other companies can use to develop products that feature Salesforce's customer relationship management (CRM) product. IBM has been working on its Trusted Virtual Data Center to strengthen isolation and integrity guarantees for customers running their programs on VMs that run concurrently on the same physical system.[5]

At present, no firm will migrate mission-critical or core applications to the cloud, mainly because of security and privacy issues. However, many other applications might benefit from the purported advantages of cloud computing: cost reductions, pay-as-you-go pricing models, quick time to market, and economies of scale. As SaaS cloud services gradually mature, large consumers such as enterprises will face critical decisions about whether to buy or lease storage from clouds,[6] whether to use IaaS services,[7] and so on. Here, we present a method to support a similar decision—whether an enterprise should continue oper-

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ating its own business software on site or subscribe to a hosted SaaS service.

SaaS: To Fly to the Cloud or Not?

Three factors are pushing the adoption of SaaS-based solutions and the cloud in general. First among them is potential cost reductions.[8] SaaS-based applications save huge up-front investments in IT infrastructure. The SaaS provider sets up and maintains the overall infrastructure, thus reducing both capital and operational costs of cloud-based software acquisition.

The second factor is the IT operational complexity that has accompanied increasingly complex applications. Software changes require significant planning and testing, and even the smallest change can involve coordinating processes across several departments. SaaS offers a simpler way to adopt and administer essential business software applications such as CRM, enterprise resource planning (ERP), social computing, and e-commerce. By offloading this time-consuming work, companies have more resources to focus on innovation.

The pressure to innovate is the third factor pushing toward SaaS. Current markets generally call for the ability to launch new products and services in a short time. Acquiring new applications as a service offers a way to get new features to market quickly. However, quick time to market is just one aspect of software product innovation; functionality is another. On-premise software development focuses on customization—adding features, even at the expense of increasing total cost of ownership (TCO). By contrast, SaaS reduces TCO by restricting the offered software's elasticity and thereby saving maintenance costs. Figure 1 illustrates these tradeoffs.

The decision to adopt SaaS also requires consideration of billing models and service-level agreements (SLAs) that define, for instance, the availability of the server and platform, the application's download time, and the effects these variables have on pricing. Even though the cloud can provide better control of response times by traffic shaping, the bandwidth inevitably decreases with increases in the distance between users and the computing source. For applications such as gaming, the browser paradigm pales by comparison to traditional thick-client solutions.

Moreover, issues such as data loss figure in the decision to adopt a cloud-based solution. The usual IT assumption is that, in spite of data-protection schemes and topologies, the only guarantee of data protection is transporting it out of the primary datacenter prior to a disaster. Cloud providers can transmit data to remote (secondary) sites using either asynchronous or synchronous replication solutions. Both solutions have advantages and limitations, presenting tradeoffs among consistency, latency, and bandwidth. Newer approaches to this problem, such as Axxana's Phoenix System, offer synchronous capabilities over asynchronous infrastructure.

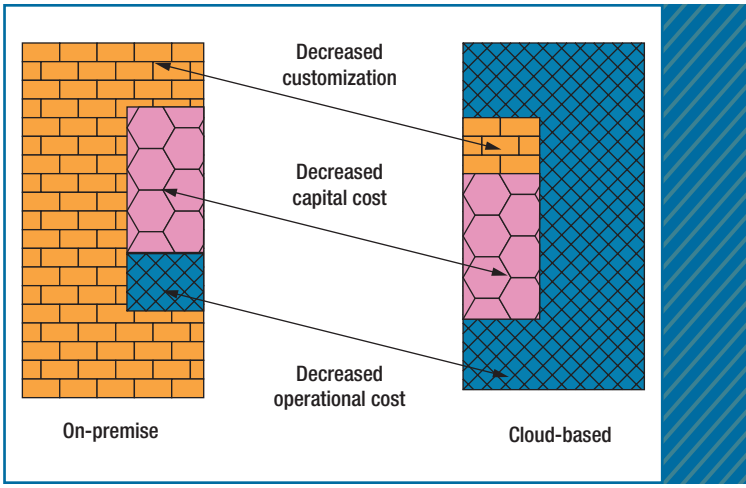

FIGURE 1. Qualitative comparison of software acquisition approaches: (a) on-premise software and (b) cloud-based software services. On-premise software development focuses on product customization as a means to market innovations, whereas cloud-based development restricts it to keep the total cost of operations low.

Other data issues relate to VM operations and improperly isolated domains. Tools to prevent data loss or leakage from these sources include strong authorization and audit, proper encryption practices and key management, datacenter reliability, and proper data disposal and disaster recovery.

Table 1 summarizes the general pros and cons of clouds in terms of strengths, weaknesses, opportunities, and threats (SWOT). Companies can tailor a SWOT analysis to specific application domains, in deciding whether to migrate an application to the cloud.

Comparative Application Costs

We developed a decision model to compare the costs of SaaS subscriptions, in-house deployment, and a combined approach that hosts an existing software application on an IaaS provider. (We apply the term "in-house deployment" both to software developed in-house and to software packages acquired in-house off the shelf.)

Our model addresses the expected up-front costs, which

TABLE 1

Strengths, weaknesses, opportunities, and threats (SWOT) analysis for migrating to the cloud.

Strengths (internal)	Weaknesses (internal)
Small capital expenses	Latency problems (until next-generation digital transfer technology becomes available)
Easy set-up	Reliability (data loss, code reset during operation)
Easy maintenance	No dedicated personnel
Horizontal scalability (number of instances)	Limited customizability
Vertical scalability (size of instances)	Limited configurability
Redundant data and services	No revenue from support operations
Opportunities (external)	**Threats (external)**
Eco-friendly systems	Data confidentiality, integrity, and availability
Elasticity	Difficulty in cloud-switching interoperability
Conversion of capital expense to operational expense	Legal problems from cross-country data distribution
Quick time to market	No clear downtime agreements or reimbursement policies
Flexible pricing, such as pay per use	No guaranteed return on investment
Tolerance to revenue decreases during crises	Compatibility issues

are one-time costs, as well as the expected annual divestment and operational costs. This kind of framework involves significant effort.[9] Our model takes account of traditional software cost estimation models,[10] information system cost models,[11] and current SLAs and popular billing methods. Table 2 lists several representative major SaaS industry players and their billing models. The dominant models are based on either usage or fixed price per user per month, although long-term commitments are becoming more common in the cloud market.

Other billing models are emerging. For example, Amazon's Spot Instances, which is currently targeting IaaS and PaaS, offers a dynamic billing model in which customers bid on unused EC2 capacity. Assuming the bid exceeds the "spot price" assigned by Amazon, customers can use the instance for the hour. The drawback is that the processing can be terminated if the bid for the next cycle is lower than the new spot price.

Decision Cost Model

Our decision model aims to help practitioners aggregate all relevant economic aspects of an IT deployment model to produce early TCO estimates (although SaaS TCO is highly dependent on the actual application and platform selected, which involves specific evaluations that are beyond this article's scope). We based our model on three types of costs that companies can combine to estimate TCO.

Up-front costs (C_u). The first type, C_u, represents the investment costs of adopting a new software system. It includes all relevant costs associated with the software, such as development (C_d) or subscription (C_{SaaS_sub}), integration and customization costs (C_{in}), professional services (C_{ps}), and user training (C_{ut}).

We can estimate C_d using a standard model or benchmarking dataset (for example, from the International Standards Benchmarking Group). C_{SaaS_sub} depends on the provider's billing model, so we can estimate it from the number of users and the average monthly subscription fee. The other cost types can be based on either estimating the amount of workload and services to be offered or using rough percentages to derive each cost type from C_d.

Hardware and middleware costs (C_h) are also accumulated to the first year's expenditures. The IaaS solution transforms hardware costs to IaaS subscription fees (C_{IaaS_sub}), usually based on the estimated number of server instances required, the middleware installed on them (operating system, database servers, Web servers), the usage levels required by the application, and the server capacities.

C_u also includes all operational costs (C_o). So the up-front

TABLE 2

Major software-as-a-system (SaaS) providers and their billing models.

Organization	Service	Billing model
Google	Google Docs	Free
Microsoft	Live services	Fixed per month or pay as you go
Salesforce.com	Salesforce CRM	Per login or per user per month
Zoho	CRM	Per user per month
OpenID Foundation	OpenID	Free
Rackspace	Cloud Sites	Pay as you go

investment costs for the in-house and IaaS solutions we're considering include all these costs, but the SaaS solution lets us exclude C_h and C_{ps}. We can therefore use the following equations to calculate C_u for each option:

$$\begin{aligned} C_{u(SaaS)} &= N \cdot C_{SaaS\_sub} + C_{in} + C_{ut} + C_o, \\ C_{u(in\text{-}house)} &= C_d + C_{ps} + C_{in} + C_{ut} + C_h + C_o, \\ C_{u(IaaS)} &= C_d + C_{ps} + C_{in} + C_{ut} + \sum_{i=1}^{S} U_i \cdot F_i + C_o, \end{aligned} \quad (1)$$

where N is the number of users subscribing to an SaaS application, S is the number of instances committed from the IaaS provider, U_i is the level of usage of each instance, and F_i is the usage fee charged by the IaaS provider according to the capacity and calculating power of the instances.

Annual divestment costs (C_{ad}). Our model's second cost type includes all relevant annual costs necessary to preserve the operation of the existing software system. Such costs involve subscription fees, software- and hardware-maintenance expenses, customization costs, and professional support fees.

We can calculate annual subscription fees for SaaS and IaaS using the criteria mentioned earlier. We can estimate annual software maintenance (C_{a_smain}), customization (C_{a_cust}), and professional support (C_{a_ps}) costs either empirically from benchmark standards or as rough percentages from the initial software development cost (C_d). C_{ps} from the second year of operation might involve consulting, user training, and support. We can calculate hardware maintenance cost (C_{a_hmain}) for the in-house solution by using a percentage of the initial hardware expenditure.

The following equations calculate C_{ad} for each option:

$$\begin{aligned} C_{ad(SaaS)} &= N \cdot C_{SaaS\_sub} + C_{a\_ps} + C_{a\_cust}, \\ C_{ad(in\text{-}house)} &= C_{a\_smain} + C_{a\_hmain} + C_{a\_ps} + C_{a\_cust}, \\ C_{ad(IaaS)} &+ C_{a\_smain} C_{a\_ps} + C_{a\_cust} + \sum_{i+1}^{S} U_i \cdot F_i + C_o. \end{aligned} \quad (2)$$

Operational costs (C_o). Among operational costs might be networking infrastructure (C_{net}), power and electricity (C_{pow}), or floor space (C_{floor}) costs. C_{net} depends on the deployment model and can include the Internet connection costs (C_{ic}), with security costs (C_{sec}) and administrator labor (C_{adm}). We calculate C_{pow} and C_{floor} only for the in-house solution:

$$\begin{aligned} C_{o(SaaS)} &= C_{ic}, \\ C_{o(in\text{-}house)} &= C_{ic} + C_{adm} + C_{pow} + C_{floor}, \\ C_{o(IaaS)} &= C_{ic}. \end{aligned} \quad (3)$$

TCO. Combining these costs, a manager could calculate TCO for a period of n years by using the simplified formula

$$TCO = C_u + \sum_{i=2}^{n} \left(C_{ad} + C_o \right).$$

Model Evaluation for a Typical Business Application

We evaluated our decision model on a single application for 50 users in the IBM Rational Team Concert (RTC) collaborative software delivery environment (http://www-01.ibm.com/software/rational/products/rtc). CloudOne is an IBM Rational partner, and we compared results from our model with results from a CloudOne TCO analysis for deploying application development software both in-house and in the cloud. For comparison reasons, we used the same license fee as CloudOne: US$7,400 per user. At the time of our evaluation, IBM offered 10 free licenses per 50 users.

In applying Equations 1, 2, and 3, in-house development in this case is the acquisition cost, C_d = $7,400 × 40 = $296,000. We derive professional services cost as a percentage from C_d. Adopting results from the Yankee Group, an IT market research firm,[12] we estimated professional services at 18 percent of the initial development cost: C_{ps} = 18% × C_d = $53,280. The Yankee Group estimates total integration and customization costs total at about 75 percent of the initial development. However, IBM RTC supports a variety of

TABLE 3

SWOT analysis for cloud adoption.

Strengths (S)	Weaknesses (W)	Opportunities (O)	Threats (T)
Increased productivity and ability to work remotely	No platform or knowledge to find/select cloud providers	New business models and improved services[13]	Dependency on external providers
Reduced personnel and resources	Time- and cost-consuming transition of all critical corporate data	Greek government funding for technology innovators	Global and national economy recession
Knowledge background and expertise in related technological areas	Difficulty in confronting organizational changes	Mobile devices and computing	Low security
Ongoing projects and open source technologies	Difficulty in customization and configuration	High awareness for the "green" agenda and new approaches to reduce the carbon footprint	No market knowledge or support by EU providers
S+O = growth strategy	**W+O = expansion strategy**	**S+T = make-up strategy**	**W+T = defense strategy**
* Selection of an open source SaaS should make it easy to plug in new ERP functions, leading to improved services * Company knowledge and expertise can better exploit possible government funding * The ability to work remotely will exploit all possibilities provided by mobile devices and new IT trends	* No platform or knowledge to find/select cloud providers: - build a formal structure for strategy and decision making - select the criteria that are important for new business models enabled by SaaS and pursue them * Time-consuming transition of all critical corporate data and difficulty in confronting organizational changes: - establish a safety mechanism - encourage and motivate employees assigned to the task * Difficulty in customization: - select an ERP relevant to the existing one - check the available automated customization modules offered by the SaaS provider - consider alternative solutions that anticipate open source SaaS (such as Apatar.com, which is in development)	* Dependency on external providers: the company has an experienced IT department that could perform certain customizations internally * Global and national economy recession: - personnel and resource costs are estimated to decrease - the CRM is expected to attract more customers * Low security: - background and expertise to establish a security process is available internally - deploy encryption, VLANs, and firewalls * No market knowledge or support by EU providers (US cloud providers are more mature); an open SaaS deployment minimizes the problem because only an IaaS provider would be necessary	* Organizational changes can be smoothly enforced by management - minimize dependency on external providers as well as security threats by defining a strategic plan to motivate employees for the organizational change - motivate employees to participate and contribute to change for data transfer, security issues, and lack of instant support * A well-established decision model for the selection of the appropriate SaaS provider can help in selecting a cost-effective deployment model that will help the company survive the economic recession

development environments, such as J2EE, .NET, and IBM i, so we considered the integration and customization costs to be much lower—specifically, 15 percent: C_{in} = 15% × C_d = $44,400. We used the Yankee Group's 3 percent for user training costs: C_{ut} = 3% × C_d = $8,880.

Hardware expenditures involved the acquisition of one server at $10,000 and the IBM Rational Team server license at $18,100 (http://estore.gemini-systems.com/ibm/software-license/rational-testing-software/software-change-and-configuration-management/rational-team-concert-standard-edition) for a total C_h = $28,100.

The operational costs include Internet connection facilities for one 24 Mbps DSL per five users. We estimated the cost of DSL as approximately $50 per line per month: $50/5 × 12 ≈ $6,000 per year. We added $900 per year for routers, switches, and hubs, so C_o ≈ $6,900 per year.

We set security cost (C_{sec}) at $800 for firewalls and antivirus packages and C_{adm} at $1,000 per year per server for a part-time administrator. We calculated power cost at $30 per server per month: C_{pow} = $30 × 12 = $360 per year. We calculated the room required for the server as 5 square meters and rental expenditures of $18 per square meter per month: ≈$1,080 per year.

Costs for the first year of IBM RTC operation thus totaled

$440,000. The CloudOne TCO analysis came to $425,005.

We calculated the SaaS deployment costs at $559 per user per month, with 10 free licenses. The cloud deployment option provides the possibility of recycled licenses (licenses shared among numerous users that are unlikely to log on simultaneously). If we make the same assumption as CloudOne—that two employees share one license—the subscription costs are C_{SaaS_sub} = $559 × (25 − 10 free) × 12 = $100,620 per year. The integration and user-training costs remain the same as the in-house deployment option: C_{int} = $4,400 and C_{ut} = $8,880. The operational costs for the Internet connection are also the same: C_o = $6,900. In total, SaaS costs $160,800 in the first year of operation. CloudOne estimates this cost as $156,870, so our cost model is in line with what practitioners use in their analysis.

Case Study

Our case study involves a large subdivision of a company in the petroleum industry. The subdivision operates in the Balkans and has 2,300 employees, mainly technicians and mechanics. Most employees work at refineries. There are 15 different departments, each specializing in different aspects of oil production, such as chemical engineering and quality assurance.

Eight years ago, the company installed an integrated ERP and CRM system, establishing a contract with SAP Hellas.

Demographics

The subdivision has about 200 SAP licenses with about three users sharing each license (through a username/password). The fee for each license is €3,000 per user per year. Four servers are dedicated to SAP.

An IT department in the company headquarters consists of eight employees maintaining and supporting SAP's system. Two of these employees are administrators. Also, each department in northern Greece has one employee dedicated to customizing SAP for the department's needs, including training and user support. The company has a LAN installation.

Current Status and Consideration of Migrating to the Cloud

In the northern subdivision, the company has 23 full-time employees dedicated to customizing and supporting the ERP system. The company is considering adopting a cloud solution for three reasons: the (possible) cost reduction, the need for executives and managers to remotely access company data, and the need to integrate the company's data after a recent expansion to nearby countries.

SWOT Analysis

We investigated the appropriateness for a cloud-based solution for the company in terms of a SWOT analysis. Table 3 summarizes the results.

Table 4 shows the costs related to the company's current in-house deployment and two alternative solutions: SaaS deployment with a popular SaaS provider and IaaS deployment that uses an open source ERP/CRM solution.

The in-house costs reflect the actual system installation costs of the current ERP/CRM system's first year of operation. The annual costs consider only the annual license fee agreement, along with hardware maintenance (on average, 5 percent of the initial hardware expenditure). The 23 employees dedicated to IT support, customization, and administration perform the remaining annual software maintenance, user training, and professional support (€1,500 per month per employee). The electricity and floor space costs are calculated for the four servers, similar to the IBM RTC example.

For the two alternatives, we attempted to minimize the cost assessment risks by considering the worst-case scenarios. For example, in the SaaS solution, we assumed that C_{ps} is 18 percent of subscription costs, and integration is 75 percent of subscription costs. User training, assuming that employees are familiar with how to use such systems, is relatively low; the same is true for the IaaS solution.

For the IaaS solution, we assumed that C_{ps} and C_{int} costs remain the same as the in-house solution. Also, we considered that possible transition to another IT deployment model would require fewer than 23 employees (17 for SaaS and 20 for IaaS). For the SaaS solution, we considered an average annual subscription fee of €130 per user (based on Salesforce.com) for 200 users and calculated Internet connection fees as one DSL per five users.

Additionally, for the IaaS solution, we assumed the deployment of open source software and, therefore, no software acquisition costs. However, we calculated the remaining software deployment activities as in the in-house case, apart from user training, and the annual IaaS subscription fee based on four servers and the utilization schema proposed by the Amazon monthly calculator (http://calculator.s3.amazonaws.com/calc5.html).

The TCO costs in Table 4 show that the SaaS solution has benefits with respect to the in-house solution, but the gain tends to decrease over a 20-year period, while the IaaS solution benefits over the in-house solution remain practically stable.

Clouds will play a large part in the IT domain over the coming years for many reasons—the additional capacity that some businesses need temporarily, the utility of clouds as neutral territory for joint enterprise operations, the business continuity or disaster recovery they offer, and the low entry costs, to name a few. However, before deciding to migrate to the cloud, companies must consider

TABLE 4

Total cost of ownership (TCO) calculations for in-house and cloud-based deployments (in euros).

System installation costs	In-house solution	SaaS	IaaS (open source)
Software costs	1,300,000(C_d)	31,200(C_{SaaS_sub})	
Professional services (C_{ps})	234,000	56,160	234,000
Integration (C_{int})	975,000	234,312	975,000
User training (C_{ut})	39,000	10,000	10,000
Hardware-middleware (C_h)	40,000		3,745
Operational expenses (C_o)	490,760	383,000	446,000
Totals	3,078,760	995,472	1,668,745
Annual costs			
Subscription fee	600,000	312,000(C_{SaaS_sub})	3,745
Software maintenance			2,000
Hardware maintenance (C_{a_hmain})	2,000		
Professional support fees (C_{a_ps})			
Customization			
Totals	602,000	312,000	5,745
Operational expenses			
Administrator/IT staff (C_{adm})	483,000	357,000	483,000
Switches, routers, wireless (C_{sec})	2,000	2,000	2,000
Network infrastructure and Internet (C_{ic})		24,000	24,000
Power, electricity (C_{pow})	1,440		
Floor space (for hardware) (C_{floor})	4,320		
Totals	490,760	383,000	446,000
Total cost of ownership			
Up-front expenses (C_u)	3,078,760	995,472	1,668,745
Recurring annual fees (C_{ad})	602,000	312,000	5,745
Operational expenses (C_o)	490,760	383,000	446,000
Total TCO for 1 year	3,078,760	995,472	1,668,745
Total TCO for 5 years	7,449,800	3,775,472	3,475,727
Total TCO for 10 years	12,913,600	7,250,472	5,734,454

many aspects of the costs and benefits. SWOT analysis is an important tool for auditing the overall strategic position of a business and its environment, while TCO analysis can provide monetary assessment of the alternative IT solutions. We plan to extend the present analysis to also calculate ROI.[14]

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ABOUT THE AUTHORS

STAMATIA BIBI is a contracted lecturer at the University of Western Macedonia and a research collaborator at Aristotle University of Thessaloniki, where she performed the work reported in this article. Her research interests include software process models, estimating software development cost and quality, cloud computing, and open source software. Bibi has a PhD in informatics from Aristotle University of Thessaloniki. Contact her at sbibi@csd.auth.gr.

DIMITRIOS KATSAROS is a lecturer with the Department of Computer and Communication Engineering at the University of Thessaly. His research interests are in the area of distributed systems. Katsaros has a PhD in informatics from Aristotle University (2004). He's coeditor of *Wireless Information Highways* (IRM Press, 2005). Contact him at dkatsar@inf.uth.gr.

PANAYIOTIS BOZANIS is an assistant professor at the University of Thessaly. Bozanis has a PhD in computer engineering and informatics from the University of Patras. He's coeditor of *Advances in Informatics* (LNCS 3746, Springer, 2005) and a member of the European Association for Theoretical Computer Science. Contact him at pbozanis@inf.uth.gr.