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Application Development Employing Web Services: Understanding Costs and Risks

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ABSTRACT
Web services are developing as an important alternative to traditional sources of application development. Web services in its envisioned state will permit firms to purchase best of breed web services and integrate these web services over the Internet into a single application based on an agreed upon level of standards. This new development method mimics how manufacturers have traditionally assembled products through standardized externally sourced components. Although web services promise benefits to the application development process a number of risks and costs exist that must be identified and addressed before implementation. Drawing on the software life cycle control model, this research proposes a framework to identify the salient costs and risks involved in the web services decision. This research may provide early insights for potential web service adopter firms and providers.

Keywords
Web Services, Software Development, IT Risk, Software Life Cycle Control Model

INTRODUCTION
Over the last few years, web services have been one of the most talked about and hyped Internet applications (McNally, 2003). With this hype it is essential that early adopters are aware of the costs and risks involved before selecting a less than mature technology for their software implementations (Stal, 2002). Web services has the potential to drastically change how applications are acquired, developed and operated, but a greater understanding of the risks and costs associated with the web services decision is needed before widespread adoption can be expected.

Definition of Web Services
Defined briefly, web services are modular software components wrapped inside a specific, standardized set of Internet communications protocols. Web services represent an evolution of the Web that allows applications to interact over the Internet based on open and flexible protocols (Farrell and Kreger, 2002). By utilizing established standards, applications can be constructed by purchasing best or breed web services and assembling them into a single interoperating application (Lim and Wen, 2003; Farrell and Kreger, 2002). In this paper, web services are defined as interoperable, standards based components that can be accessed over the Internet on demand and assembled to perform specific business processes.

Motivation for the Study
The transactional web that is evolving through web services will be dominated by business to business transactions and contracts (Gottschalk 2002). It has been suggested that organizations would be better served to purchase and construct their applications using web services components (Lim and Wen, 2003; Murray 2003). The growth in web services is evident. In 2003, $2.2 billion was spent on web services projects and is expected to grow to an estimated $25 billion by 2008 (Koch 2003). This trend is supported by a survey of Fortune 2000 companies, where 93% of the companies state web services as a key initiative and will likely deploy at least one web service within the next 24 months (Surmacz, 2003). With these large growth forecasts, investments and initiatives firms are exposing themselves to a number of costs and risks. However, there is little published research available addressing the inherent costs and risks involved with web services as an applications development strategy. To address this gap, the research question in this paper is formulated to identify salient web services risks and costs. Drawing on the Software Life Cycle Control Model (SLCCM) (Serva, Sherer, and Sipior, 2003) this research
develops a framework for identifying the salient risk and cost factors involved in utilizing web services as an application development strategy.

**Similarities to Traditional Manufacturing**

Web services as a new development method mimics how manufacturers have traditionally assembled products through externally sourced components. In traditional manufacturing, outsourced components designed with standardized interfaces require much less coordination with suppliers, and provide cost and performance advantages (Novak and Eppinger, 2001). Firms typically enter into a supplier-manufacturer relationship to: (1) increase the overall efficiency of the process, and (2) to tap into external resources, otherwise inaccessible to enhance the internal assets and capabilities of the firm (Sohrero and Roberts, 2001). Firms utilizing web services for their software development are hoping to leverage these similar manufacturing environment benefits.

**SOFTWARE LIFE CYCLE CONTROL MODEL (SLCCM)**

As proposed by Serva et al. (2003), the software life cycle control model (Figure 1) will be applied to identify the costs and risks involved with application development utilizing web services (Table 1). The SLCCM is based on transaction cost economics (TCE), which has been widely used to explain IT related governance strategy decisions (Willcocks and Lacity, 1995; Wang, 2002). According to the SLCCM, the total life cycle cost consists of the total cost of ownership (TCO) and total life cycle risk (TR). This framework is appropriate because web services as a software acquisition strategy encompasses similar properties to application service providers as evaluated by Serva et al. (2003). TCO includes the sum of the original acquisition cost (AC), cost of operations (OC), maintenance costs (MC) and coordination costs (CC):

\[ TCO = AC + OC + MC + CC \]

Total risk (TR) is equal to the sum of the opportunism (OppR), operations (OpnR) and development risks (DR):

\[ TR = DR + OppR + OpnR \]

When the sum of the TCO and TR of acquiring a product (external) is less than the sum of the TCO and the TR for producing the product on its own (internal), firms typically decide to acquire the product externally.

\[ [TCO + TR \ (External)] < [TCO + TR \ (Internal)] \]  \[ \Rightarrow \]  \[ \text{Acquire Product Externally} \]

The following is a brief discussion of the SLCCM proposed by Serva et al. (2003). The SLCCM suggests that increasing or decreasing control along the operations and features control dimensions affects both costs and risks. These dimensions will be extended to identify the costs and risks associated with the web services decision.

<table>
<thead>
<tr>
<th><strong>Acquisition Cost(AC)</strong></th>
<th>Costs of obtaining the software: including development, purchase and customization.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operations Cost(OC)</strong></td>
<td>Cost of operating software: including cost of running programs, external hosts and distributing output to users.</td>
</tr>
<tr>
<td><strong>Maintenance Cost(MC)</strong></td>
<td>Cost of maintaining software: including internal and external costs for upgrades, corrective, and adaptive maintenance.</td>
</tr>
<tr>
<td><strong>Coordination Cost(CC)</strong></td>
<td>Cost incurred by a firm in coordinating with actual or potential producers of the software and/or operating and maintaining the software.</td>
</tr>
<tr>
<td><strong>Development Risk(DR)</strong></td>
<td>Risk that the system is not developed according to the user requirements.</td>
</tr>
<tr>
<td><strong>Opportunism Risk(OppR)</strong></td>
<td>Risk associated with loss of bargaining power in vendor relationships that may affect the maintenance, development and/or software operations.</td>
</tr>
<tr>
<td><strong>Operations Risk(OpnR)</strong></td>
<td>Risk incurred after the software is developed, during operation and maintenance, often resulting from parties shirking on agreed upon tasks.</td>
</tr>
</tbody>
</table>

| **Table 1. Costs and Risks in the Software Life Cycle** |

**Software Features Control Dimension**

The features control dimension describes the ability of the purchasing firm to customize the software to achieve specific business requirements. Firms have the option to develop customized software or purchase generic software. The more customized the software, the lower the operations risk, since the firm can be assured that the software is satisfying specific business requirements. Customized solutions are often found to become more expensive to operate and maintain over time as
the company’s needs mature (Serva et al., 2003). Generic purchased software typically offers little control over features and is usually less customizable when compared to customized software development. However, generic software typically offers lower costs and risks when compared to customized software. The development risk in generic IT solutions is lower since the external software developer has already addressed the development risks. Generic solutions tend to have lower opportunism risks since the company will not be as dependent on a few knowledgeable employees or vendors when using customized solutions, since expertise is available via the market for generic solutions.

Software Operations Control Dimension

Internal versus external control in this study refers to the entity that controls the software operation. It does not refer to the physical location of the software, but who is actually controlling the operation. Internal software control typically reduces operations risk by allowing firms greater control over their information technology systems and company specific secrets. Internal operations typically have less coordination costs, since all control is done internally without depending on external market transactions. However overall costs are typically higher for internal operations. External control of software operations through outsourcing has emerged as an attractive source for controlling the IT costs and operations for many firms (Levina and Ross, 2003; Currie and Willcocks, 1998; Lacity and Willcocks, 1998). This reliance on external vendors for software upgrades, maintenance and operations increases opportunism risk because a firm can lose its expertise and internal IT skills (Novak and Eppinger, 2001).

![Software Life Cycle Control Model](SLCCM.png)

**Figure 1. Software Life Cycle Control Model (SLCCM)**
WEB SERVICES SOFTWARE LIFE CYCLE CONTROL FRAMEWORK

Web Services Features Control: Costs

Web services can be viewed as a hybrid of generic and customized solution techniques typically involved with application acquisition. The reusability nature and standardized interfaces allow web services to be reused by many organizations. The reselling of the similar web service across organizations should result in cheaper acquisition costs because of economies of scale achieved by the web services provider. Operations costs should be lower because the solution is customized and selected to fit a company’s requirements. Firms’ are afforded the flexibility to replace a given web service with another if a cheaper or more efficient web service is available.

All web services following the standardized interfaces of SOAP, WSDL, and UDDI should interoperate and communicate. The interface created through the standardized interfaces should eliminate the need to customize an application to allow for coordination and integration between different applications. The result should be lower coordination costs between applications. The Internet has been suggested as one way to reduce coordination costs (Serva et al., 2003), and since web services are based on open Internet standards the coordination costs should be lower than other application acquisition strategies.

Web Services Features Control: Risk

The development risk for web services is expected to be lower than customized solutions and similar to the low development risk achieved through generic IT solutions. Given that the web service has been developed externally, the web service vendor has already addressed the development risks. Opportunism risk should also be lower through web services. Opportunism risk has been found to be lower for firms who are not locked into a specific vendor and for those who have the option to switch to an equally effective supplier (Lonsdale, 1999). The lower asset specificity characteristics of web services will create fewer opportunities for web service vendors to exhibit opportunist behavior. Web services customers are not bound to their initially selected web services vendor. As long as the web services follow the established standards, web services replacement should be similar to plug and play.

Web services will allow firms to customize their software applications by having the ability to purchase best of breed components and assembling these components into a single interoperating application. Resulting in increased control over choosing product features to fit the firm’s specific requirements. This increased flexibility and control to choose customized features will allow the firm to produce customized software applications with lower operations risk.

Web Services Operations Control: Costs

The acquisition and operations costs for web services are expected to lower by taking advantage of the economies of scale provided through the web services model. The cost advantages of web services are predicted to be significant for firms that lack significant IT resources who cannot achieve internal economies of scale in application development. Similar to outsourcing, web services are predicted to offer improved management focus on core activities and access to technical talent and resources not available in-house (Dan, Davis, Kearney, Keller, King, Kuebler, Ludwig, Polan, Spreitzer, and Youssef, 2004). Conversely, coordination costs are often cited as a downside to the outsourcing decision (Lacity and Willcocks, 1998; Levina and Ross, 2003; Wang, 2002), but are expected to be controlled by the use of web services.

Maintenance costs for web services are a developing area of concern. Maintenance issues have been cited for component based software environments, regarding responsibility requirements for improvements and enhancements to the components (Vitharana, 2003). Questions remain for web services as to who will perform the maintenance and ensure that the upgrades will be compatible with current implementations.

Web Services Operations Control: Risk

The decreases in development, coordination, and operations costs must be weighed against the risks of utilizing web services. Operations risk will be lower due to the increased control the customer possesses to specify the features and services purchased during the web services transaction. Opportunism risk will be lowered through the open standards of web services. In order for the suggested benefits and interoperability to occur, vendors must agree on these basic standards (Basu and Kumar, 2002). These agreed upon standards will provide the consumer greater flexibility in replacing and substituting web services once dissatisfaction develops with a currently implemented web service. The proprietary standards that have plagued the interoperability between software components and in essence locked-customers into a specific vendor’s solution will be replaced through the standards based interoperable web services.
WEB SERVICES DECISION FRAMEWORK

The classifications provided through the SLCCM may be used to guide the web services software development decision. Table 2 describes the various software acquisition strategies extended to include web services. The SLCCM has been shown to be effective in framing the decision to utilize ASP as an appropriate application strategy (Serva et al., 2003). From the applied framework, it appears that organizations interested in lowering their acquisition costs, operations costs, development costs, operations risks, opportunism risks and coordination costs should consider web services as their software acquisition strategy, but empirical and case study work is needed to support this claim.

<table>
<thead>
<tr>
<th>Components that increase along both control dimensions</th>
<th>Components that decrease along both control dimensions</th>
<th>Mixed Components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal Sourcing</strong></td>
<td>Operations Risk(OpnR)</td>
<td>Coordination Cost(CC) Opportunism Risk(OppR)</td>
</tr>
<tr>
<td>Acquisition Cost(AC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations Cost(OC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Cost(MC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Risk(DR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outsourcing</strong></td>
<td>None</td>
<td>Acquisition Cost(AC) Operations Cost(OC) Maintenance Cost(MC) Development Risk(DR)</td>
</tr>
<tr>
<td>Coordination Cost(CC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunism Risk(OppR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Purchased Software</strong></td>
<td>Coordination Cost(CC) Opportunism Risk(OppR)</td>
<td>Acquisition Cost(AC) Operations Cost(OC) Maintenance Cost(MC) Development Risk(DR)</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ASP</strong></td>
<td>Acquisition Cost(AC) Operations Cost(OC) Maintainence Cost(MC) Development Risk(DR)</td>
<td>Coordination Cost(CC) Opportunism Risk(OppR)</td>
</tr>
<tr>
<td>Operations Risk(OpnR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Web Services</strong></td>
<td>Acquisition Cost (AC) Operations Cost(OC) Operations Risk(OpnR) Development Risk(DR) Opportunism Risk(OppR) Coordination Cost(CC)</td>
<td>Maintenance Cost(MC)</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Extension of Serva et al. 2003

Table 2. Effects of Different Sourcing Options

LIMITATIONS

This study extends the SLCCM, which faces the limitation of reliable and valid metrics for TCT (Novak and Eppinger, 2001; Serva et al., 2003). Future work on the development of appropriate measurements for each cost and risk component would strengthen the study, and is expected to be completed in phase two. However, our work does introduce guidance to the web services acquisition decision by identifying the different costs and risks involved. The immaturity of the technology, lack of widespread adoption and empirical work discussing web services decisions weakens the arguments suggested. Even with the discussed limitations, the suggestions provided in this paper are expected to serve as guidance for the web services decision.

CONCLUSION

This study brings attention to web services as an application development strategy. The SLCCM was applied to identify the salient costs and risks involved in the web services decision. The SLCCM suggests how organizations can evaluate their software acquisition decision and select the appropriate software acquisition strategy for their own unique situation. The next step is the empirical test of the model through case study and survey research in partnership with web services vendors. The potential contribution of this study is to provide early insights into understanding costs and risks involved with utilizing web services as a software development strategy.
References