OPEN SOURCE SOFTWARE AND LEVERAGING OF BUSINESS EFFECTIVENESS IN SMES
A Case Study

Steven Butler, Dotun Adebanjo
Management School, University of Liverpool, Chatham Street, Liverpool, U.K.

Hossam Ismail
Management School, University of Liverpool, Chatham Street, Liverpool, U.K.

Abstract: This research investigated the issues that impact on an SME adopting e-Business. It was found that many barriers may exist for e-Business adoption in an SME. One of which is limited financial resources to purchase internet technology required for e-Business adoption and development. However, open source technology has grown in popularity for a number of years, with governments, business firms, military and educational organisations incorporating open source software. This paper provides an overview on open source technology which could be adopted for e-Business architecture for the development of e-Business applications. Furthermore, it provides two action research case studies on SMEs adopting open source software for the development of e-Business capabilities. It was found the projects were successfully developed and implemented for each case study company. Although successful, the research team found that more research is required in open source software for the development of e-Business applications.

1 INTRODUCTION

In the United Kingdom (UK), Small-to-Medium Enterprise, (SMEs) provides a significant contribution to the economy. Some authors report the contributions to Gross Domestic Product (GDP) up to 40 percent (Taylor and Murphy, 2004). The world economy is changing, with growth in emerging markets and developing economies continuing to outstrip that in developed economies, (Jutla *et al*, 2002). This has resulted in more pressure on SMEs to discover ways in which to deliver its products and services more effectively, and improve operations activities to remain competitive.

The growth in the internet and e-Business applications has provided organisations with new opportunities to offer products and services, share information with business partners and meet customer demands. Therefore, e-Business applications and the internet have the potential to increase the competitiveness and growth of small firms, (Paliwoda, 2004). E-Business applications

provide an organisation with the opportunity to extend business functionality by providing users, such as employees, suppliers and customers to access business logic through a browser, or commonly referred to as 'business though a browser'.

E-Business applications and architecture uses a three-tier client server model, as illustrated below in figure 1. A three-tier client server model is where the client is mainly used for display with application logic and the business rules partitioned on the server, which is the second tier, and a database server is the third tier. (Chaffey, 2004).
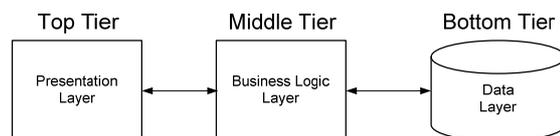

Figure 1: Three-tier architecture.

Although e-Business can provide so many opportunities, many barriers may exist, preventing

an organisation adopting e-Business. The effective adoption and implementation of ICT may rely quite a lot on individual factors such as organisational size, structure, mix of available human and financial resources and capabilities (Pavic *et al*, 2007).

This is further supported by resource issues relating to finance, skills and personnel are expected to impact on the decision to adopt e-Business, (Fillis *et al*, 2004). Research has found that there are a number of barriers and success factors associated with e-Business adoption for an SME. (Taylor & Murphy, 2004) identified high initial set-up costs of ICT and e-Business can act as a barrier for an SME. Clearly, SMEs are presented with a number of challenges to realise the benefits e-Business that can provide to an organisation. However, open source technology may provide a solution by providing access to technology which may not be cost prohibitive.

1.1 Open Source

Open source is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in (Open Source Imitative OSI, 2008). Open source software has grown in popularity in recent years, with governments, business firms, military organisations, and educational entities incorporating open source software into their enterprise functions to counter tightened budgets and rising operational expenses (Hedgebeth, 2007). Any reservations that exist regarding security may be short-sighted, with financial services institutions such as Experian, embracing open source software recently, (Ferguson, 2008). It appears open source popularity will continue to grow, with predications that by 2012, more than 90 percent of enterprises will use open source in direct or embedded form, (Judge, 2008).

Open source appears to be here to stay, but what open source software is available which can be used to develop e-Business applications, based on an e-Business three tiered architecture (Figure 1).

2 TECHNOLOGY REVIEW

The research team identified various Database Management Systems (DBMS) which could be used in the data tier of the three-tier architecture. The research team analysed SQL Server, Microsoft Access and MySQL to consider suitability for e-Business applications for the case study.

Microsoft Access is a DBMS developed by Microsoft Corporation and belongs to the Microsoft Office family of products. Microsoft Access includes database functions that allow users to perform database queries and has some very good reporting interface. Microsoft Access is a flexible package and is suitable for organisations that have small database requirements and require few database records. In a database environment with multiple users, connections and queries, Microsoft Access will probably become unreliable and slow. However, Microsoft Access can be less expensive than some other DBMS on the market.

Microsoft SQL Server is another Microsoft package, but this product is primarily marketed towards large organisations with large database requirements. SQL server is an enterprise-level database system and is widely used in organisations that require a database that can handle high use, multiple transactions and offers high reliability. Microsoft SQL server is certainly a viable option for large organisations and the cost highlights this, while SQL server is an expensive option and requires a lot of training to be able to use the product effectively.

MySQL is an open source project which has been publicly available since 1996, but has a development history going back to 1979, (Welling & Thomson, 2003). MySQL is a relational database management system (RDBMS), which enables data storage, searching, sorting and retrieval. MySQL has many attractive features which include speed, ease of use, query language support, capability, connectivity, security and portability (DuBois, 2003). MySQL has become a popular database solution as its popularity within the database community has increased and would probably suit most database needs.

It should be noted that there are several database options available and the views expressed by authors, practitioners and application developers on available database systems varies significantly. Many developers and practitioners may have a bias towards database systems with which they may have had previous experience. It is clear that the choice of database system will depend on a number of factors such as price, speed, efficiency, etc. The database comparison table illustrated below in Table 1 highlights the differences in the most suitable database systems available.

The research team analysed suitable scripting languages for the business logic layer of the three-

tier architecture. The research team analysed ASP, ASP.NET and PHP to consider suitability for e-Business applications.

Table 1: Database Comparison.

	Access	SQL Server	MySQL
Cost	Inexpensive	Expensive	Free
Speed	Weak	Strong	Strong
Efficiency	Weak	Strong	Strong
Users	Few	Many	Many
Connections	Few	Many	Many

ASP is a server-side scripting language developed by Microsoft to run dynamically generated HTML pages. ASP was originally introduced with Microsoft's server platform and utilises VBScript, a variation a Visual Basic Language, consequently both Microsoft products. Although scripting languages have been changing rapidly, many competing technologies have introduced new integrated features, while ASP has been lacking in this area. However, many business environments have Microsoft servers. This is probably a major driver for the continued use of ASP and ASP supports Microsoft SQL server, which is also widely used.

ASP.NET is part of Microsoft's .NET platform and should not be confused with ASP. Although both are developed by Microsoft, the only other link between both technologies is that they both use VBScript. ASP.NET can be used to build dynamic web sites, web applications and XML web services. ASP.NET offers developers the ability to build pages using controls such as buttons or labels, with properties assigned to the controls. The controls produce segments of code, e.g. HTML for forms. This concept introduces the idea of all the code behind the page. This may reduce development time, but it is fair to conclude that programmers and/or developers will always need a deep understanding of the technology, even with the .NET concept of code behind the page.

PHP is an open source scripting language and was originally started as a hobby, this programming language has grown in popularity and use in recent years. It can be imbedded into HTML pages and allows communication with a database. A number of databases support PHP, which include MySQL, dBASE, Microsoft SQL Server, Oracle and many more. PHP supports most back-end databases, but it is most commonly known for its seamless integrations with MySQL. It can also run on a number of operating systems such as Windows, Linux, MAC OS and most varieties of Unix.

Furthermore, it is well supported by several PHP discussion groups and communities. PHP has grown from a set of tools for a personal home page development to the world's most popular web programming language, and it now powers many of the Web's most frequent destinations (Shiflett, 2006).

The choice of ASP, ASP.NET or PHP will ultimately come down to the application requirements and the hosting provider environment. The choice will also include the developers' familiarity with programming language. If the developer is familiar with C, Java, JavaScript, etc, then PHP may be the best choice. If however, the developer has little experience of programming languages the choice may be the .NET concept of code behind the page. ASP.NET or PHP would be more suitable for e-Business applications, as software support and updates for ASP becomes redundant in the future. The technology comparison table illustrated below in Table 2 highlights the differences in the most suitable technologies available.

Table 2: Scripting Language (Source: Oracle).

	ASP.NET	PHP
Cost	Free	Free
Platform Cost	Expensive	Free
Speed	Strong	Weak
Efficiency	Strong	Weak
Security	Strong	Strong
Platform	Strong	Weak (IIS Only)

A number of technology options exist for e-Business applications and only a handful have been analysed due to suitability and requirements for the e-Business applications to be developed in this paper. This paper investigates the use of open source software for e-Business applications as access to financial resources can be limited in an SME.

The research team found that MySQL would be the most suitable database option for each case study organisation due to cost, stability and security. MySQL is a true open source database management package. As a result, the research team decided that PHP would be the most suitable scripting language, as it works seamlessly with MySQL and, once more, it is an open source product.

Therefore, the research team agreed to develop the e-Business applications using MySQL and PHP for the data layer and business logic layer, respectively. MySQL or PHP do not require a commercial licence and all are battle-proven on high volume websites. Apache was selected to provide the web server environment. The apache web server

open source project was developed and as an open source HTTP server for operating systems such as Unix and Windows. Apache has been the most popular web server on the internet since 1996 (Apache, 2008). Apache is also the most popular web server and has the largest market share, used on over 50 percent of web servers, (Netcraft, 2008). The software selected for the development of e-Business applications are Apache, MySQL, and PHP are open source software and are known collectively as AMP.

3 CASE STUDY

Organisation A was a micro-size manufacturing organisation based in the UK. The research team also found that the case study company was experiencing sustainable growth, with a year-on-year sales change of more than forty percent. The case study found that the organisation was suffering from 'growing pains' in a number of areas of the business. The research team carried out interviews, process review meeting and structured walk-through to understand business operations and indentify improvement opportunities. It was found that the organisation used office applications and had a legacy system for stock management, but many of its key processes were paper-based and manual. It was found that the organisation was becoming inefficient in a number of its key processes. The research team and management reviewed all improvement opportunities to identify 'urgent improvements'. A key process in the dispatch department was causing a bottle neck and affecting other areas of the business. This was identified for improvement actions. The process was know as the 'verification process', was critical to the business, and directly affects the organisations ability to service customers.

This process was a manual process. It required personnel in the dispatch department to validate the data on six documents against a master data sheet to ensure all the data on the documentation matches that on the master data sheet. Once complete, a manager would then be required to repeat this process to verify all the documentation was correct, and data was not overlooked accidently. This activity was required to be completed on every product. It was a critical step, as the data and information contained on the documentation comprised of product information, safety data and certified values.

Organisation B case study was a medium-size car finance broker based in the UK. This organisation has been established for some time, with a growing finance portfolio. The primary role of this organisation was to link car dealerships and finance organisations able to provide funding for vehicle leasing and purchasing, acting as an intermediary. The organisation used a proprietary off the shelf software package to support its operations. The software did allow some customisation, but it was found this had its limitations.

Through management briefings, conducting interviews and process reviews at each visit, it was possible to identify issues and problems with business processes. The research team identified issues with current business processes, data integrity, processing time and legacy system. The organisation rely on external parties, (car dealerships), to provide legible and complete information for finance proposals. It was found that proposals are hand written by car dealerships and then faxed to the contact centre for processing. Once received, employees were required to transfer the information on each proposal onto the legacy system. However, if an application has not been hand written in a legible format employees were expected to decipher information on the proposal, presenting the organisation with data integrity issues.

Furthermore, it was found that because proposals were faxed this affected the quality of information on a proposal. The organisation team were fully aware of this problem and were keen to resolve this issue through the use of technology. The research team identified this as an area of improvement, as improvements, or elimination of data integrity problems would provide the organisation with clear and accurate information and more efficient business processes.

The organisation offers products which require a decision of acceptance or decline within two hours. It was found that sometimes this is exceeded due to incomplete or incorrect data collection, which necessitated follow up actions and telephone calls by employees resulting in extended processing time. It was found that if the processing time extended beyond two hours then a dealership would source finance from a competitor, resulting in lost commission for the organisation.

4 RESEARCH AIMS & OBJECTIVES

The overall aim of this study was to determine ways in which open source software may be used to develop e-Business applications to improve business processes in each case study organisation. The research focuses on identifying suitable open source software to develop such applications. The research then moved onto proposing solutions utilising internet technology, and then developing e-Business applications. To achieve this aim, a number of key objectives would have to be met. These key objectives include:

- Identity open source software for e-Business applications.
- Determine ways in which solutions can be developed using internet technology.
- Develop e-Business applications for each case study organisation.
- Identify benefits e-Business provided each organisation.
- Use findings in the paper for the development of an e-Business framework for an SME adopting and implementing e-Business.

5 RESEARCH METHODOLOGY

The primary research for this paper is based on a case study of two UK based SMEs, the first is in the manufacturing industry, and the second is involved in the financial services industry. Two case study organisations were selected for this paper so that research could be completed on a manufacturing organisation and non-manufacturing organisation. The case study is action research lead in both cases. In first case study the research team spent more than 18 months working with the case study company on an e-Business development programme, to develop e-Business capabilities and implement operations management tools and techniques. An associate from the research team was based at the case study company throughout the programme.

The second case study company is a medium-size enterprise based in the UK. The organisation investigated the use of internet technology in both front and back end activities to improve business operations to minimise processing time and data integrity issues to improve competitiveness of the organisation.

The research team carried out several face-to-face interviews with stakeholders from case study A and B. The interviews with case study A were primarily carried out with key stakeholders, but this was then extended to include employees involved in business processes to better understand each process. Once each process was fully understood, the research team then began identifying areas for improvement through the development of a web-based system.

In respect of case study B, initial interviews were held with senior management (directors), and the Information Technology (IT) manager. The research team began with understanding existing business processes. This process enabled the research team to understand finance proposal process from initial enquiry to release of funds.

In case study A and B the research team was involved in the system analysis and development process for each web-based solution. In case study A, the research team designed web-based applications to improve existing process, data handling and reduce resource requirements. In case study B the research team designed a new e-Business application to link car dealerships and the case study company to improve operational activities and enable information sharing. In both cases the research team developed the e-Business applications using open source software, which had been designed for each case study organisation.

6 FINDINGS

Organisation A

It was decided that a web-based verification application would be developed by the research team to improve the 'verification' process for organisation A. The study had already identified that access to financial resources for technology development would be a constraint. This resulted in the stakeholders agreeing that the 'quick win' project should be developed through the utilisation of barcode and open source technology. This was the perfect opportunity for both the research team and the organisation to witness the viability and suitability of open source technology, which was a new concept to the case study company.

The web-based application would be developed so that barcode data on a product master data sheet could be scanned and stored on a database. The data required for validation would be stored in barcodes on product documentation when printed. An

employee could then use the verification application to complete data verification checks using a barcode scanner. The application would check the barcode data on the documentation, against the master data stored in the database, informing the employee of a pass, or fail. This would result in eliminating management from this process, as the employee would not be required to perform data verification, thus eliminating human error from the process.

The application successfully developed with open source technology (APACHE, PHP and MySQL). It was successfully implemented and replaced the existing manual process, thus improving the process significantly. It was found that the new application provided several benefits, such as more efficient business processes within the dispatch department because the current bottle neck had been eliminated. This in turn helped speed up the dispatch of goods from the department. Furthermore, through better utilisation of human resource management, more time can now be spent in other areas of the business, which could provide even more cost savings or help improve revenue streams through new product development.

The total project cost for the application was calculated at £4006.35. This included hardware, software, training and development costs. The new process provided a resource saving of fifty percent and a noticeable improvement in throughput time. This was calculated as a total cost saving of approximately £20K in the first year, providing an approximate five hundred percent Return on Investment (ROI) for the case study company.

It was found that the verification system provided a number of benefits which could not be fully quantified. Some of which included the ability of the case study to eliminate the bottle neck observed in the department. This in turn helped increase the throughput of goods in the dispatch department. Furthermore, through better utilisation of human resource management, time can be spent in other areas of the business, which could provide even more cost savings or help improve revenue streams through new product development. The process was de-skilled, resulting in any employee being able to perform verification using the web-based system, after initial training.

In addition, the development of the web-based application includes the storage of data, using the MySQL database. As a result, management can use the data to monitor the process and retrieve historical data to help make business decisions. Finally, the research team found that knowledge and understanding of e-Business application had been positively witnessed and experienced by the entire organisation. Management and personnel involved in the verification process have commented that without the adoption of the system, it would have been impossible to meet current customer demands using the existing approach.

Organisation B

The research team and employees from the organisation reviewed several web-based applications used by competitors and organisations providing financial services. This provided the initial concept of a web-based application to the organisation. The research team held focus group meetings to discuss, and identify desirable functionalities of the proposed web-based application. It was agreed that the application would also include finance quotation tools for dealerships to use whilst using the web-based proposal form. It was thought this would enhance value proposition to dealerships, thus encouraging adoption. The web-based proposal form would include validation functions to ensure that all required information was completed on the form before submission, thus ensuring data integrity and minimising errors, thus reducing processing time.

It was agreed to develop and implement the solution in phases. In the first phase the solution developed would store all the proposal information in a database. The proposal would then be encrypted and emailed to the organisation for processing, this would replace the fax. The next stage of development would look at identifying solutions to allow data sharing between different operating systems and programming platforms.

The organisation successfully implemented a web-based e-Business application using open source software (PHP & MySQL). The application improved information flows between the car dealerships and the organisation, replacing the paper passed proposal application process. The application was first released to field sales staff for review and testing, before being released to car dealerships. However, it was identified that the next stage of the development may be more difficult, as the application would be required to share data directly with legacy systems, posing a security risk. Furthermore, a dealership has requested information sharing between both organisations to simplify the proposal process. If the organisation can provide a solution, the dealership as agreed to complete all business transaction with the case study company. This has resulted in the proposal for the application to be developed further, into a web service.

7 DISCUSSION

Although both case study organisations had implemented e-Business applications successfully using open source software, the research team found that a number of barriers existed, which included access to skills, key personal and business culture issues.

It was found that Case Study A had little knowledge of e-Business, e-Business applications or the benefits and opportunities that could be realised by an organisation adopting e-Business. The research team managed to involve as many employees as possible in the development of the e-Business application, to help deepen knowledge and understanding and encourage buy-in at all levels of the organisation. It was also found that the organisation lacked the necessary skills and knowledge to develop e-Business applications. Moreover, the research team found that access to personnel required to implement and deploy the application was limited, due to personnel involved in other business activities. Once the e-Business application was successfully implemented, the research team arranged a feedback meeting to ascertain personnel experience of e-Business. It was found that the approach to involve personnel had been received positively, as personnel felt that e-Business knowledge and understanding was now evident throughout the organisation.

It was found that Case Study B Company did have knowledge of e-Business applications, but did not fully understand how internet technology could be deployed to improve operational activities. The research team found that the organisation did have an information technology department, which were highly skilled in a number of areas, but did not possess the necessary skills to develop e-Business applications. Moreover, it was found that access to personnel was limited, similar to the first case study organisation. Clearly, key stakeholders must appreciate that access to personnel is required, which may remove personnel from daily business activities. The project feedback meeting found that all involved had a positive experience and found open source could provide significant benefits to the organisation. This organisation is now looking to develop the e-Business application into a web-service for its dealership network. This will also be developed using open source software.

This paper had already indicated that access to software can be cost prohibitive, but this was overcome through the utilisation of open source software. However, a number of other barriers for each organisation were observed by the research team, and these need to be considered by academics and practitioners involved in e-Business development projects for SMEs. Although many barriers may exist, each organisation experienced e-Business benefits, as illustrated below in Table 3 and Table 4.

Table 3: Case Study A - e-Business Benefits.

Cost Saving	Process Effects	Culture Effects
£20K (year 1)	Bottle neck removed	e-Business knowledge & understanding
	Data integrity	e-Business buy-in
	Increased throughput	Positive experience of open source software
	De-skilled process	Open-source buy-in
	50% human resource saving	

Table 4: Case Study B - e-Business Benefits.

Cost Saving	Process Effects	Culture Effects
N/A	Information sharing	e-Business buy-in
	Legible data	Positive experience of open source software
	Reduced processing time	Open-source buy-in

8 CONCLUSIONS & FURTHER WORK

The case study found that SMEs face a number of challenges, and that e-Business can provide opportunities for organisations to improve business operations, information sharing and remain competitive. However, they may face several barriers to e-Business adoption, one of which is access to technology. It is found that access to new technology can be cost prohibitive, or existing legacy system costs may prevent further investment in technology. This may be overcome by the use of open source technology.

The research team found that open source software can be used for the development of e-Business applications, namely MySQL and PHP. E-Business applications were developed and implemented for two case study organisations, to

support business processes and enable information sharing. Supporting the view of (Bocij, 2003) e-Business is aimed at using information and communications technology to integrate and enhance processes. In a value-chain context, the efficiency of processes is enhanced, which should result in lower-cost, higher quality products so giving the customer better value.

Although open source technology may provide an SME with an opportunity to develop low cost e-Business applications, access to personnel with the skills, experience and knowledge of such technology is still required. Therefore, more research into access to open source skills is required to ensure that open source technology development can be supported in the future.

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