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Closing the Loop: Providing Web Service Solutions Enabling E-Logistics Integration

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Abstract

In the context of today's business world, collaboration is becoming increasingly important to companies in their attempt to achieve competitive advantage, not least in becoming flexible to meet the constantly changing demands placed on organisations to excel in their sector and achieve growth in the most cost effective manner. The implementation of distributed computing technology is thus an essential element of business strategy. Web services enable the development of remote, distributed enterprise applications. Lower costs of integration may also allow businesses to create new business value by improving data exchange in corporations, with business partners and even competitors. This research focuses on investigating Web services as an integration technology in the context of service logistics and in particular on-line service logistics software delivery through an Application Service Provider (ASP) model. The research serves to outline some of the key considerations necessary for Web services technology to be utilised in the development of robust, useful and cost effective solutions for service organisations. The research considers the case of a service logistics software development organisation that has implemented Web service-based e-integration projects for customers. Key employees in customer organisations provide input to the research findings. A primary objective is to develop insights into the areas where Web service technology can be applied to improve the software solutions provided to these customers.

1. Introduction

Web services have emerged as the potential integration technology of the future. Multinational organisations such as Microsoft and Sun have undergone considerable changes in order to deliver on the promise of Web services. Proprietary technologies such as Electronic Data Interchange (EDI) and Common Object Request Broker Architecture (CORBA) have failed to impact sufficiently in the service logistics sector. Repair organisations utilise spreadsheets as a tool for tracking key information from the point of sale to the end-user and subsequent repair. However, this tool is ineffective in integrating the systems of multiple organisations involved in the reverse supply chain. Effective integration of systems across diverse locations and multiple organisations is essential to manage the return of consumer products. Web services are essentially "enterprise applications that exchange data, share tasks, and automate processes over the Internet" (Shirky, 2002). This technology, which takes advantage of the ubiquitous nature of the Internet, is non-proprietary, relatively easy to implement and has the backing of major players such as Sun, Microsoft and IBM. The possible "improvements in application integration, coordination and data interchange" (Shirky, 2002) between multiple parties involved in service logistics processes is discussed as part of this research. The research aims to identify the benefits that may be derived in service logistics organisations through the use of Web services technology. This will provide insights into the advantages associated with incorporating Web services into the business strategy of a service logistics software solution provider in order to provide useful and worthwhile solutions to customers.

2. Theoretical Foundation

Web service architecture allows applications to be designed using modular business functions that can communicate and interact with each other. These *"coarse-grained business functions"* (Chung *et al.*, 2003, p. 35) can be dynamically accessed across multiple organisations and from diverse platforms (Hagel, 2002). Alameh (2003, p.23) characterises Web services as *"self-contained, self-describing, modular applications that clients can publish, locate, and dynamically invoke across the Web*". Each Web service can be invoked or called independently of other Web services or applications. Web service architecture extends across a number of stack layers that interact to allow the creation and consumption of Web services (Table 1). A Web Service Description Language (WSDL) document describes the interface to a particular Web service. A business or user may develop a Web service to perform a function and publish it on the Internet using a standard known as Universal Description, Discovery, and Integration (UDDI). Other standards include Simple Object Access Protocol (SOAP) for XML messaging and Hypertext Transfer Protocol (HTTP).

Table 1: Web Service Standards (Hündling and Weske, 2003)

Stack Layer	Web Service Standard
Service Repository	Universal Description, Discovery, and Integration (UDDI)
Service Description	Web Service Description Language (WSDL)
XML Messaging	Simple Object Access Protocol (SOAP)
Transport	HyperText Transfer Protocol (HTTP), Transmission Control Protocol (TCP), or Simple Message Transfer Protocol (SMTP)

2.1 Service Logistics

Service logistics is an industry characterised by the multiple parties involved in business processes. Ludwig and Klüber (2003) explain that technical and business potential of Web services is such that benefit can be derived from the technology in the implementation of new business functions (Table 2). Projects can be completed with minimised costs "by way of optimising development spend through application re-use" (King, 2003, p. 1) and therefore minimising Total Cost of Ownership (TCO) of new systems. Manufacturers can focus resources on delivering new and improved products with market value to the end-users, safe in the knowledge that they can collaborate efficiently and effectively with the service organisations to ensure that the value proposition for their products extends throughout the lifecycle of the products.

Table 2: *Potential of Web Services (Ludwig and Klüber, 2003)*

Web services technical potential
Utilisation of existing development staff skills
Minimising Total Cost of Ownership (TCO) and development costs
Reduction of complexity of integration projects
Web services business potential
Reduced time-to-market by using and enhancing existing services
Increased flexibility
Reap new opportunities through increased functionality and lower costs

Logistics is an element of the supply chain process that involves the transfer of goods or services from the point of manufacture to the point of consumption in order to meet the market demand (Tibben-Lembke and Rogers, 2002). Reverse logistics can be defined as the reverse of this. Reverse logistics has in the past been overlooked in the broader context of Supply Chain Management (SCM). Sweeney (2003) explains that there are two strategic reasons why companies focus on reverse logistics. Firstly, cost reduction can be achieved by reduced return rates, increasing asset recovery, reduced inventory and reduced compliance costs. Secondly, the goal of achieving customer service is enhanced through decreasing average Turn Around Time (TAT), increasing follow on sales and increasing customer retention by ensuring that all complaints are dealt with effectively.

Service logistics is a component of logistics that can be defined as "all logistical issues around the implementation of closed loop reverse logistics in the electrical and electronic goods sector" (Sweeney, 2003, p. 5). Sweeney (2003) further explains that service logistics describe reverse logistics for all products that carry a unique serial number identifier. It may be described as closed loop as the customer returns a product for repair, exchange or credit. It also encompasses the supply of spare parts to the point of repair. Ludwig and Klüber (2003) state that Web services technology could be effectively applied to the implementation of integration solutions for the global logistics industry. Robust Web services offer an ideal way to connect the different organisations involved in the supply chain with low integration costs.

2.2 Strategic, Organisational, and Managerial Benefits of Web Service Technology

Manes (2003) explains that the most significant motivation behind Web service technology is application integration, as organisations invariably have multiple application systems possibly in diverse locations. The motivation manifests itself in two ways; firstly, tactically businesses require improved application integration in order to enhance operational efficiency and reduce costs and secondly, from strategic perspective organisations require better access to information to enable more accurate decision making. Organisations must evaluate the business strategy in order to become more agile and respond rapidly to changing market conditions (Srinivasan and Jayaraman, 1999). Web services may be used in service logistics to *"significantly change the cost structure associated with maintaining software systems"* (Stencil Group, 2003, p. 8). By adopting Web services technology, manufacturing organisations can look to other areas of business process improvement in order to achieve increased productivity. By leveraging a suite of Web services, real-time repair data can be provided which allows managers to assess the quality of product manufactured and thus support improved strategic decision-making.

Web services components reside in Web-based servers where they can be invoked by any Web-enabled application from any machine such as a PC or handheld device (Vaughan-Nichols, 2002). Applications no longer need to sit on a user desktop PC and all devices can be integrated into a *"virtual computing fabric"* (Vaughan-Nichols, 2002, p. 18). Web services promise to decrease unit cost and increase return on information systems investment by sharing functionality across boundaries (Langdon, 2003). Web services components may be used in two ways; firstly, for integration or e-business automation in enterprises and secondly, for client application design. The latter involves the possibility of Web services enabling the design of applications that do not reside on client machines but, rather, are accessed as required through the composition of Web services. Web services provide an appropriate means for designing effective middleware that hides the diversity and complexity of underlying processes. The technology is lightweight avoiding intrusive object models and single programming language requirements and is interoperable (Vinsoki, 2003). Langdon (2003) claims that enterprise systems such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Supply Chain Management (SCM) systems can be more tightly integrated though the use of Web services technology while remaining adaptable to changing business requirements such as new products or business partners.

2.3 Challenges Facing Web Services Technology

Despite the documented benefits of Web services technology there are still a number of issues remaining. Hagel (2002) suggests that there are two principal technical challenges that need to be addressed in the development of XML-based Web services. Firstly, the

growing integration costs should be considered, as multiple custom connections may be required for data sharing amongst several organisations or even locations. Secondly, continual redefinition of connections poses a significant problem causing significant burden on resources, as businesses attempted to ensure connectivity between Web sites and Internet applications. Staab *et al.* (2003) outline the following five issues that Web services need to address:

1. *Efficiency.* The execution of Web services must be efficient to ensure scalability to enterprise application integration.
2. *Expressiveness.* The complex enterprise business processes required for integration purposes require expressive concept modelling.
3. *Security.* Data transfer across and between enterprises must be secured to prevent attack and loss of data integrity.
4. *Reliability.* Communication using Web services must be reliable so that messages are sent once to ensure dependable interactions between the involved parties.
5. *Manageability.* The Web service process for e-business automation must be manageable so that organisations can monitor usage and delivery and also enable easy update to Web services interfaces due to frequent enhancements.

Another unresolved issue with regard to Web services technology is that providers of a service will *"clearly want to earn revenue based on service consumption"* (Lim and Wen, 2003, p. 55). Contracts and billing standards must therefore be addressed to provide the basis for negotiation between the consumer and the provider. Support for measuring compliance with service-level agreements and for providing payment mechanisms must be included in Web service standards (Langdon, 2003). Heflin and Huhns (2003) outline several limitations of Web services technology for transforming the Web into semantic, machine-interpretable format. Firstly, a Web service knows only itself and not its users, clients or customer. Secondly, Web services are not designed to reconcile formats among themselves and clients, also they are passive and cannot provide alerts or updates as new information becomes available. Autonomous semantic Web services provide the means for automating usage of data across the Internet that would *"support capability-based discovery and integration at runtime"* (Paolucci and Sycara, 2003, p. 35).

3. Research Objective and Approach

The objective of this study is to investigate Web services as a technology to facilitate the development and deployment of service logistics software solutions. This research serves to evaluate why and how web services technology may be suitable for the delivery of e-logistics integration solutions. A two-phased study was conducted, with the initial data collection and analysis focused on document analysis which was used to inform the interview guide. Given the qualitative, exploratory nature of this research, a case study was employed as the most fitting research approach. Interviews were conducted with employees of a small service logistics software development organisation and employees of customer organisations who are actively involved in overseeing the implementation of these solutions. The interviewees were chosen through the use of positional methods (Knoke, 1994). They were selected based on their positions, offering rich insights into the area with their knowledge of the service logistics industry, their experience with the case organisation, and their knowledge of issues that must be considered for the implementation of service logistics solutions and the implications associated with moving

to a new technology for this purpose. Each interview was taped and lasted approximately 45 minutes in duration. A number of the interviewees have been represented in this study with the use of aliases to protect their privacy and opinions. The findings were interpreted in the context of the integration of the multiple organisations that interact in service logistics processes. Finally, the research identifies some of the key benefits and implications of the use of web services technology in the delivery of integration solutions for the management of service logistics processes.

4. Background to the Study

Since 2002, Chip eServices have provided highly scalable Web-based solutions suitable for large enterprises to manage post-sale activities. The solutions provide manufacturers and appointed repair organisations with the ability to collaborate efficiently and effectively with data shared across the parties. The solutions also provide manufacturers with the ability to develop high-quality on-line post-sale service relationship management directly with customers. Solutions are delivered using the Application Service Provider (ASP) model. The solutions that Chip eServices provides are targeted directly at the niche market of service logistics sector in the manufacturing industry. The sector is characterised by the repair of all electronic and electrical goods ranging from consumer electronics such as Discmans, Stereos, DVD Players and Televisions to high-tech storage devices used in data centres worldwide and the standard desktop PC or laptop. OEM organisations in the sector are large multinationals such as Sony, Philips, Teac, Dell and Apple. These are worldwide organisations that require integration across diverse systems, platforms and locations. To maximise profits these organisations must provide quality service to the end-users of the products. These organisations give standard warranty periods with the products within which they are obliged to repair the products for free. Also, they may sell extended warranty periods to end-users. Service obligations are fulfilled through payment to Authorised Service Providers or Service Centres for the repair services.

The primary application developed by Chip eServices, myRMA.net, focuses on managing Return Material Authorisation (RMA). RMA is the term used to describe the generation of a return authorisation following the establishment of a fault in an electronic product. The Client returns the product to an Authorised Service Provider that processes the faulty product by repair or disposal, and then returns the repaired product, an exchange product, or credit to the Client (Table 3). The Authorised Service Provider operates on behalf of the OEM manufacturer of the product.

Table 3: RMA Process

RMA Participant	RMA Function
Warrantor	The manufacturer of the product and sells the product to the Client.
Client	After purchasing the product the Client requires service. A business Client would use myRMA.net to manage returns to its key supply base.
Service Centre	A department of the Warrantor or an independent operator. The Service Centre processes RMAs by completing the loop by credit exchange or repair.

There is a third party relationship involved in the RMA process. myRMA.net assumes responsibility for the management of the entire process and because the application is offered on an Application Service Provider (ASP) model, all of the data is stored centrally by Chip eServices, and can be updated on a real-time basis by any one of the parties, allowing the other RMA participants immediate access to status information. The RMA participant organisations require integration capabilities in order to ensure that the RMA process data stored by Chip eServices is accessible within the organisation to legacy systems for internal functions such as reporting and auditing.

Chip eServices has adopted Web services as the key mechanism for e-integration between the myRMA.net product suite and customer systems. The organisation has developed Web service-based synchronisation technology that allows customers to retain an up-to-date local copy of their service logistics data. One customer uses this data to post data to their internal ERP system for integration purposes. The synchronisation mechanism was further refined to allow a repair organisation to upload data from their internally developed Service Management System (SMS) to myRMA.net. Real-time data is then available to the Warrantor organisation and can be used to analyse world-wide service logistics issues. Recently, a new project involving integration with a global logistics operator has become tactically and strategically important to a customer organisation. This research serves to identify further areas of application of Web services in order to optimise the global and cross-boundary applicability of Chip eServices service logistics software solutions.

4.1 Customer Organisations

These service organisations have implemented or are in the process of implementing service logistics solutions using the suite of applications developed by Chip eServices (Table 4). The management of the information flows in *"boundary spanning"* relationships between multiple organisations is one of the key goals of the software development at Chip eServices. These processes extend the relationship between the manufacturing organisations and the repair organisations, retailers, and end-users. The interviewees have a great deal of knowledge of the service logistics industry and this is a prime reason for their selection as part of the interview process. In order to effectively develop solutions for these organisations Chip eServices need to understand the difficulties that they encounter in the management of their service logistics processes. Employees of these customer organisations also offer insights into the implications of moving to new technologies, such as Web services, based on practical experience. Chip eServices can then improve their understanding of the applicability of Web services technology in the development of these solutions. The organisation must strive to continually enhance and improve the quality of the solutions and furthermore must remain competitive in the after-sales software market by utilising state-of-the-art information technologies. Web service technology has been adopted by the organisation for this purpose.

Table 4: Customers Organisations

Organisation	Business	Relationship to Chip eServices
Vendlink Communications	Mobile phone top-up machines	Vendlink are currently using myWARRANTY.net to store warranty registration information. They intend to integrate this solution with myRMA.net to manage the call centre and repair process for the machines.
Teac	Recording and reproduction equipment.	Teac implemented an RMA Wizard solution using ServiceCentreSync that allowed their TPM's to upload RMA information directly to myRMA.net. The application used Web services to accomplish this task.
Tyco/Sensormatic	In-store security products for loss prevention	Sensormatic implemented myRMA.net to manage their European Service Centre in Cork, Ireland.
Philips Electronics	Consumer Electronics	Philips intends to implement myRMA.net to manage the return of consumer electronics to Service Centres around Ireland. The organisation may also implement a warranty registration solution using myWARRANTY.net
Storage Devices Inc.	Storage devices	Storage Devices Inc. is in the process of implementing a warranty solution using myWARRANTY.net and will ultimately integrate this solution with myRMA.net.

5. Analysis and Discussion of Evidence

By definition, the service logistics industry is boundary spanning in nature with multiple organisations involved in the repair process (Figure 1). These organisations include the manufacturers of electronic and electrical goods, the *"repairers"* (Philip, Service & Environmental Manager, Philips), the retailers and the end-users. Web services technology can be used to *"solve a great deal of communications, service and support issues"* (Jo, Service Manager, Teac) associated with the information flow between these *"integration points"* (Jerry, Managing Director, Chip eServices). Web services implementations also offer the advantage of *"code reusability"* (Dwayne, Software Architect, Chip eServices). Distributed computing across multiple service organisations can harness the modular nature of Web services to provide cheaper, robust, reusable components that can be incorporated into client applications at any node in the service logistics chain.

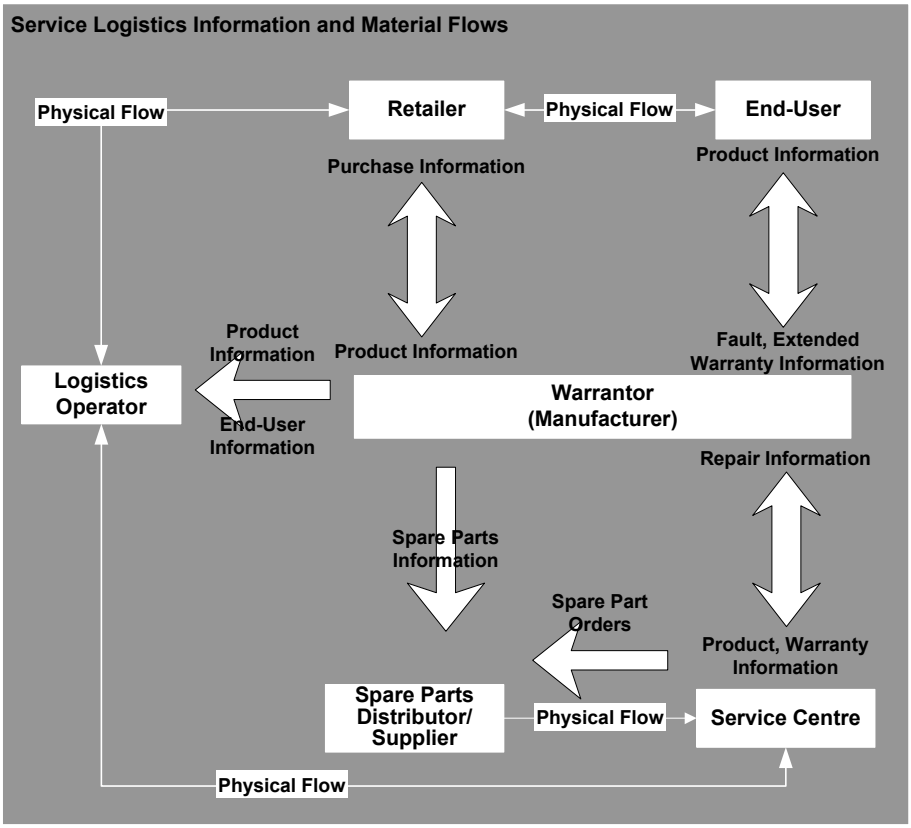

Figure 1: Service Logistics Supply Chain

The complexity of the information flows between each node in the chain illustrates the need for systems to effectively manage the constituent processes and interactions. One key issue is the automation of information flows between each of the parties involved in the service logistics supply chain (Table 5). IT systems designed using Web services technology can diminish the inherent complexities. Dwayne (Software Architect) explains that the *"interoperability of Web services"* heralds significant advances toward full automation of information flows in the service logistics sector. Each organisation involved in the reverse supply chain is dependent on the availability of information from another. As pointed out by the Service & Environmental Manager at Philips, the manufacturers *"originate a lot of the information"* but most of the information resides with other people. Providing a mechanism to retrieve this information is a strategic necessity for service organisations.

Table 5: Examples of Web Service Implementations

Information Flow	Web Service Implementation
Transfer of Service Centres repair data to Warrantor	Service Centres input repair data using a Web services interface. Warrantor has real-time access to the repair data.
Transfer of warranty information to Service Centres	Repair organisations have real-time access to a serial number database with warranty information using a Web services interface.
Transfer of spare part order information from Service Centres to supplier	Service Centres access a Web service method to place orders with the supplier. The order information is immediately available to the supplier.
End-user registration for warranty entitlements or purchase extended warranty	End-users access the manufacturers Web site and input warranty registration information to oblige Warrantor to repair the unit in the event of a fault

Operational efficiency across service organisations and manufacturers can be improved as warranty obligation information for the repair of products can be made available through Web service implementations to the Third Party Maintainers (TPMs) or Authorised Service Providers. The repair organisations can then determine whether to charge their customer for repair of a product. According to the Service & Environmental Manager (Philips), this is an area where Web services technology may be most suitable in the service logistics industry; *"in or around the claims process – that always causes the most difficulty"*. The repair data is also of critical importance to the manufacturer in order to deal effectively with repeat complaints, and improved access to information *"can be used to improve the quality of new product development"* (Jo, Service Manager, Teac). Web service implementation can provide a means to deliver complex repair data from client applications in the repair organisations to manufacturers. Composition of Web services can be used to improve application integration by sharing data across boundaries. This is illustrated in the case of spare part ordering where real-time data can be accessed by suppliers to ensure prompt supply of spare parts to the point of repair. Strategically, this may also improve customer service levels, which can help to increase the consumer confidence. Jerry (Managing Director, Chip eServices) explains that *"warranty registration or returns tracking functionality"* is the type of process that can be implemented using a Web service portal *"opened to customers"* (Jo, Service Manager, Teac). The improved *"data visibility"* (Paul, Senior Service Engineer, Storage Devices Inc.) across the entire service logistics chain can lead to improved organisational tactical and strategic decision-making.

5.1 Inadequacy of Traditional Systems – Web Service Benefits

The limitations of *"platform dependent, traditional, proprietary systems"* can be overcome through implementation of Web service solutions (Table 6). Web services technology takes advantage of standardised technologies such as Extensible Markup Language, Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL). The technology is non-proprietary so solutions implemented using the technologies are relatively inexpensive. Also, the solutions are flexible due to the platform-independence of the technology, and the ubiquity of the Internet.

Table 6: Issues with Proprietary Systems (Service & Environmental Manager, Philips)

Issue	Problem explained	Importance of solution
Incompatibility	Traditional proprietary systems tend not to be compatible with the systems of other organisations.	Service logistics is boundary spanning with multiple organisations and information flows involved. These systems need to be compatible for each party involved in the reverse chain.
Inflexibility	The proprietary systems cannot handle service requirements such as serial numbers.	Repairs must be tracked on a serial number basis due to warranty registration – to ensure that warranty obligations are met and customers do not abuse the system.
Information Management	Operational management is difficult using Excel. Management information cannot be extracted easily.	Operations include the day-to-day activities around providing the required quality of customer service whilst on a strategic level data must be accessible for management reporting and decision-making.
Knowledge	There may be knowledge gaps for the development of methods to manage the information using Access for example.	Knowledge in service organisations is primarily to do with the day-to-day repair of customers' products. The organisations should focus on these key strengths rather than attempt makeshift solutions that may not be robust and easy to use.
Bi-location	Proprietary systems are not Web-based and cannot be accessed from multiple locations. Protection of integrity of the data cannot be guaranteed.	The information must be accessible to each party involved in the reverse chain and it must be accurate to ensure that the service organisation can manage the processes effectively.

The first issue explained by Philip's Service & Environmental Manager is that of incompatibility between the systems of business partners. Due to the inherent characteristics of Web services the technology offers advantages over traditional service logistics systems. The technology addresses integration difficulties across disparate and diverse systems due to the interoperability of the technology. The ubiquity of Web services overcomes past bi-location barriers that limited automation of information flow between service organisations. Inflexibility in traditional proprietary systems is also overcome through the development of Web service implementations. Service logistics information systems must be flexible in recording information relating to warranty registration and repair data and this information must be readily available to relevant parties involved in the reverse supply chain. For example, a serial number database tracking warranty can be made available through a Web service interface to repair organisations. The improved application integration by sharing functionality across boundaries can help to improve operational efficiency. Traditional technologies fail to offer the level of operational and strategic management that is required in service organisations. Brian (Production Manager) cites the availability of better information to Vendlink's service engineers to help them in diagnosing and fixing any problems with the mobile top-up machines as a key advantage of Web services. Field technicians update information such as repairs, requests for spare parts, spare parts used, and issuing of replacement units on a real-time basis using portable devices. Ultimately, management accounting information improves resulting in a more *"accurate reflection of stock in the field"* (Brian, Production Manager).

Table 7: Technologies used for Integration

Technology Utilisation	Advantages	Disadvantages
Electronic Data Interchange (EDI)		
Not used in service logistics. Used extensively for ERP integration in and between large organisations e.g. in sales department or in automobile industry.	Effective data transfer Widely adopted/accepted standard Effective error tracking tools Standards defined worldwide	Expensive to implement Requires expensive networking infrastructure, Proprietary technology Platform dependent Not interoperable Restrictive standard
Fax/Email and Spreadsheet		
Used extensively for information flows between service organisations. E.g. repair data, warranty processing, and spare parts order. Usage declining.	Includes human element Widely used	Slow Inaccurate No real-time information Cumbersome Not on-line or shareable
Flat file transfer		
Cited by one interviewee for transfer of data for integration		Crude Needs manual reprocessing
Web Site Integration		
Cited by one organisation for spare parts integration	Links TPM to spare parts ordering system	Manual ordering through logging into Website No integration with SMS
Others		
CSV	Cited by one interviewee for transfer of data for integration	
Access	Cited by one interviewee as an alternative to Excel. However, knowledge gap for internal development of a solution.	
CORBA/COM	Interviewees unaware of the technologies.	
Web Services		
Has not been used in service logistics but will be used extensively in the future	Low cost alternative to EDI Provides flexible solutions Reusable modular applications Web-based Interoperable	New technology *"Untried/untested"* Version control Security Messages are *"beefed up"* by SOAP

Current technologies have been relatively unsuccessful in adequately addressing the main integration issues involved in the service logistics industry. The principal failings of technologies such as spreadsheets, email, flat file transfer technology, website integration and EDI were identified during the interview process (Table 7) The majority of interviewees concurred that while EDI is a widely used technology in the area of ERP integration, the technology has never been used *"within the service part of the business"* (Service & Environmental Manager, Philips). Jerry (Managing Director, Chip eServices) explains that while EDI is *"the de facto standard ... for boundary spanning businesses"*, service organisations are small and *"it is more likely that Web services will be successful because it's a lower cost solution for more flexible relationships with smaller suppliers"*. Additionally, Web service technology offers the distinct web orientated advantage of interoperability. The most predominant technology cited is spreadsheets, which are

transferred using the media of email and fax to other organisations in the reverse chain. The spreadsheet is *"by far the most common way of swapping information across boundaries between companies"* (Philip, Service & Environmental Manager). The usage of the inaccurate and tedious medium of the spreadsheet could be replaced by a robust and cheap solution based on Web services technology that would allow *"real-time update"* (Paul, Senior Service Engineer) of information resulting in improved reporting functions within the organisations.

Table 8: Strategic suitability of Web services technology in service organisations

Characteristics	Examples	Strategic Benefit of Web Service Solution
Service Logistics Information Flows		Suite of Web services provides a simple implementation of service logistics processes for each of the information flows
Boundary spanning involving multiple organisations Physical flows of goods Complex information flows	Repair data	Statistical analysis of the repair data improves product development allowing organisation to gain competitive advantage
	Warranty information	For Service Centre dealing with warranty claims becomes easier through accessing warranty registration database using Web service Warrantor knows only legitimate claims are processed
	Spare parts order	Service Centres place order using Web service Spare parts are received promptly Customer service levels improved
Integration Issues		Suite of Web services allow can be accessed from any number of integration points in the reverse supply chain for a manufacturer
Integration with Web-based applications Integration with ERP – internal systems Integration across boundaries of organisations involved in service logistics	myRMA.net with Baan/SAP	Platform independent nature of the technology means that any system can be integrated Web services available across Internet regardless of location Code reusability – there may be only one implementation of the Web services that can be invoked from any application anywhere Allows *"portals"* for e-business to be opened in Websites
	E-business capability into a Website	
Issues with Proprietary Systems		Suite of Web services overcome issues with proprietary systems through the implementation of client applications that invoke the service methods
Incompatibility Inflexibility Information Management Knowledge Bi-location	Excel / Access	Web services are interoperable Offer flexible solution – data can be accessed by any department Information is available for decision-making WS can be developed by external companies allowing service organisation to focus on core strengths Web services are Web-based so bi-location issue addressed

Bhaswar (Business Analyst) cites simple flat file transfer technology as an integration technology. However, he identifies a number of limitations associated with the

technology, commenting that it *"is pretty crude"* and requires *"plenty of monitoring and error logging"*. In the event of too many errors the files *"may then have to be manually reprocessed"*. Alternatively, Web services technology may be used to simplify the data transfer process. *"XML dataset[s] of information"* (Dwayne, Software Architect) could be returned from a relational database, wrapped in a SOAP message and passed reliably over the Internet. Philip (Service & Environmental Manager) cites *"Website integration"* as the mechanism through which Philips' Authorised Service Providers (ASPs) can link to a European spare part ordering system. Jerry (Managing Director) explains that Website integration is the *"current state of the art"* for integration in service logistics. Philips system allows the ASP's to order spare parts from anywhere in Europe but they have to log in and enter the spare parts manually. The complexity of the channels and inherent *"business logic can be encapsulated in the Web services"* (Dwayne, Software Architect) provide a flexible solution where all parties in the reverse supply chain for a particular manufacturer have access to the same system through a suite of Web services. Table 8 summarises the strategic suitability of Web services technology in service organisations as discussed by those interviewed.

6. Conclusion

This research focuses on the suitability of Web services technology for the development and deployment of service logistics solutions. The research was carried out using a case study supported by elite respondents from customer organisations. Key employees at these organisations were interviewed to provide a rich discussion of the research topic. Evidence from this study indicates that Web services technology is suitable for the service logistics industry and should be actively adopted by service organisations either through developing a relationship with external software organisations such as Chip eServices or by promoting the technology within their own organisations so that IT managers are aware of the benefits associated with this type of architecture. Chip eServices has already successfully adopted Web services technology but recognise the need to improve its Web service strategy through creating an awareness of the technology throughout the service logistics industry, by marketing comprehensive, robust solutions that are developed using a suite of Web services.

The nature of the service logistics industry involving complex information flows between multiple organisations is a prime reason for the adoption of Web services technology in the development of solutions to implement automated information processing between organisations. A service organisation can integrate with external partners across the reverse supply chain so that the data visibility is apparent throughout and benefits all parties involved through added value that increases consumer confidence in a brand or product. The data that is dispersed throughout the reverse supply chain can be leveraged to assist in the realisation of these strategic goals. The long term strategic benefits to the organisation are tangible i.e. time and money savings, as the efficient and effective transfer of data between organisations is optimised as a result of implementing Web services. In this way, each node in the supply chain adds value and quality to the products across the value chain resulting in increased consumer confidence and increased profitability for all parties involved. Effective integration of systems across diverse locations and multiple organisations is essential to manage the return of consumer products. Additionally, organisations can utilise the technology internally to improve reporting functions. Strategically this enables the production of quality management reports that aid the decision-making process in service organisations. Traditional proprietary systems used in service organisations can be replaced by a series of client applications that invoke methods from a suite of Web services that implement the primary service logistics processes. Reporting and client applications can be provided to

organisational management that utilise the same Web services (and data), allowing strategic decision-making to be carried out using real-time data. These 'Smart Clients' utilise Web service technology to integrate with central enterprise systems across the Internet providing access to real-time data for more accurate strategic decision-making throughout the organisation. Web services are key to providing extensive functionality as services are offered that increase the integration between the parties involved enhancing collaboration and cross-boundary virtual enterprise management.

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