University of Southern Queensland

Business-to-business communication and the requirements for an ontology for the Australian Timber and Wood Products Industry.

A dissertation submitted by

Jacqueline Blake, BIT(Distinction)

For the award of
Master of Information Technology (Research)

2006

Executive Summary

The purpose of this thesis is to describe business-to-business communication and the characteristics of an open standard for electronic communication within the Australian timber and wood products industry. The current issues, future goals and strategies for using business-to-business communication identified by respondents in a questionnaire are discussed.

The study addresses these questions, by using a self-administered questionnaire which was constructed and mailed to 2000 organisations. The questionnaire was used to ascertain a base-line of information systems' use in the Australian timber and wood products industry, and to establish how to make successful the introduction of a more accessible means for system to system interoperation between organisations.

A prototype domain specific ontology was engineered using content analysis of a representative timber and wood product organisation product listing. A visual representation of the ontology modelled using unified modelling language is presented. The formal specification of the ontology was constructed using an ontology editor, Protégé.

The outcomes of the questionnaire include that the industry has a small number of large enterprises and a large proportion of small to medium enterprises. Computer and Internet use in the industry is comparable to that in other Australian industry sectors. For both intrabranch and business-to-business the established communication modes of postal service, telephone and facsimile are those most frequently used. However where advanced information technology modes exist, it is used extensively. Use of electronic data interchange is now used mostly by organisations employing over 100 employees, whereas supply chain management use is limited. Small to medium enterprises have failed to adopt an information systems strategy plan, while organisations employing over 100 do have plans in place. Attitudes toward information technology, business-to-business communication and information systems security are dependent upon organisational size while compliance to information systems' standards was not. Barriers to adoption of technology specific communication identified in the study are location, lack of resources, organisational size and a lack of planning.

Drivers to increase the bandwagon effect in the industry are education and the availability of a simple low-cost complete package to demystify technology intensive electronic business-to-business communication. For the ontology to proceed to a standard a collaborative effort must be made by industry partners to reach consensus on an acceptable standard.

CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

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Signature of Candidate Date

ENDORSEMENT

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Signature of Supervisor/s Date

Acknowledgements

I wish to acknowledge the support of the Forestry and Wood Products Research and Development Corporation of Australia <www.fwprdc.org.au> whose interest and financial assistance has made this project possible**.**

A large number of people have helped me, throughout this research project, to which I wish to express my gratitude. Mr Wayne Pease, principal supervisor, who provided me with help, advice and who persisted in pushing me to do better. My husband Peter, children Prue and Hamish, parents and friends who supported me, were tolerant of my schedule and never doubted that I would complete the project.

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1.0 Background to the research

The Australian forest and wood products industry contributes seven and half per cent of the manufacturing output of the gross domestic product (GDP) with a turnover exceeding 14 billion dollars per year (Australian Government Department of Agriculture Fisheries and Forestry 2003). Overall the industry sector supports 674 hardwood mills and 268 softwood mills along with 30 panel board mills (Australian Bureau of Agricultural and Resource Economics 2003) employing approximately 130 000 people in the 2003 year (Forest and Forest Products Employment Skills Company Limited 2003). The proposed study describes how organisations in the Australian Timber and Wood Products industry manage business-to-business (B2B) communication in the supply chain. Current issues, future goals and strategies for using business-to-business communication within the industry are discussed. A proposal for characteristics of an open standard describing timber and wood products for use in electronic communication is made.

A previous study by Forest and Forest Products Employment Skills Company Limited (2003) details how the industry is fragmented with a lack of whole industry data. The forestry industry is growing in importance in Australia, with the stated aim of the Department of Agriculture, Fisheries and Forest (1997) according to its 2020 vision document being to treble tree plantation area by the year 2020.

The business process of supply chain management provides an opportunity to improve business efficiency within this industry, increasing profit margins and thus favourably impacting on the Australian economy (Handfield & Nichols Jr. 2002). An opportunity of improving the efficiency of supply chain management is provided by emerging information and communication technologies. Electronic Data Interchange (EDI) is an established technology that provides business-to-business communication within the supply chain but demands rigid agreements between organisations concerning the structure and content of communications. From the widespread use of Internet technologies has arisen a new EDI paradigm, that of web-based EDI. This paradigm adopts a flexible, non-platform specific open standard or ontology for unambiguous communication so that standard message agreements between organisations participating in the supply chain can be more readily brokered (Nurmilaakso, Kettunen & Seilonen 2002). An ontology provides the means of solving the problem of interoperability when semantic heterogeneity is an issue (Fensel et al. 2003).

One of the mechanisms semantic technologies provides for brokering agreements is by providing instruments designed for unambiguous, loosely coupled, data sharing. An ontology provides for the explicit specification of domain knowledge external to any one system, to which an organisation commits. These external ontologies may provide an open standard for B2B communication through the industry sector. Semantic technologies use the domain knowledge to provide machine interpretable context sensitive information which may be shared. Semantic search engines using these

ontologies allow the retrieval of context sensitive information that may be coupled with intelligent agents to provide brokering and negotiation capabilities (Schoop et al. 2002). Ontologies for domains other than an industry sector are available, for instance the web service modelling ontology proposed by Roman et al. (2005) uses semantic technologies to automate tasks of web service discovery, composition and invocation.

Standards Australia International Ltd (2003) in their BizDex web site quoted the former National Office for the Information Economy (NOIE) who estimated that the extensive use of cost effective B2B automation would return as much as two percent of the GDP back to the economy. A consensus built standard set of descriptors for timber and wood products will provide a tool to build automated B2B document exchange systems in this industry.

1.1 Research problem

This study seeks a solution to the problem of improving B2B communication thus achieving supply chain efficiency to gain a competitive advantage in the market place. In order to seek this solution the study attempts to answer the following two main questions:

- *How do organisations in the Australian Timber Industry manage business-to-business communication in the supply chain currently and in the future?*
- *What are the characteristics of an open standard for electronic*

communication within the industry?

1.1.1 Sub-problems

1. How do the organisations define B2B communication?
2. What system of B2B communication do they currently use?
3. What issues do they have with B2B communication now?
4. What issues do they see as critical for future B2B communications?
5. What strategies do they suggest to gain the desired future B2B communication functionality?
6. What comprises a standard library of elements that will describe attributes of timber and wood products in B2B communication?

I found that the industry has a large proportion of small to medium enterprises, which rely on established forms of communication. I conclude that there are a number of barriers to the adoption of electronic B2B communication. I conclude that while a foundation for an open standard may be built, a useable standard can be built only by consensus amongst industry partners.

1.2 Justification for the research

Australian forest and wood products industry sector forms an important element of the Australian economy. Information technology has facilitated new communication paradigms which can assist this industry.

1.2.1 Australian forest and wood products industry

The Forest and Forest Products Employment Skills Company Limited (FAFPESC) (2003) report on their data collection survey identified some challenges in studying the forest and wood products industry. One of these challenges is the diverse nature of the organisations involved in the industry, with the industry being compartmentalised into a series of sectors such as the pulp and paper manufacturing and sawmilling sectors. These sectors have very little sense of belonging to the timber and wood products industry as a whole (Forest and Forest Products Employment Skills Company Limited 2003). The FAFPESC (2003) report detailed the lack of statistical data collection relating to this group, also the unwillingness of many organisations in the industry to disseminate any organisational information outside of existing business contacts.

1.2.2 Supply Chain Management

A supply chain is the flow of information, materials, finances and services stretching from the procuring of raw materials through to the delivery of the finished product to the end user (Turban et al. 2004). The management of the relationship amongst participants in the supply chain is undertaken by supply chain management. Management of the supply chain is done with the intent of improving customer service, cycle time reduction, increased inventory turnover, and increasing flexibility and adaptability in the system. Improvements in these functions increase the effectiveness of business

processes leading to improved organisational performance (Prem PremKumar 2003).

Supply chain management is the integration and optimising of the flow of material, information, services and finances, related to the transformation of a raw material to a finished product and delivered to an end user (Prem PremKumar 2000; Turban et al. 2004). The information flows' associated with the supply chain must transverse barriers both within the organisation and between organisations which share supply chain information. Inter-organisational information sharing brings decision making by consensus to supply chain participants. Electronic transactions work to support the sharing of information and the building of strong relationships between customers and suppliers (Ball et al. 2002). Participants in a supply chain with information sharing derive competitive advantage from an efficient supply chain (Ayers 2001; Ball et al. 2002). Trust is an important component of the relationship between participants in the supply chain, promoting the sharing of information (Handfield & Nichols 2002; Sahay 2003; Schneider 2003).

1.2.3 Trust between trading partners

Schurr and Ozanne (1985) declare that trust is the certainty that a party's word or promise is dependable and that the party will fulfil their obligations in an exchange relationship. Communication and information sharing is an important facet in building a level of trust between trading partners (Schneider 2003), as trust reduces uncertainty in another organisation's

actions (Sahay 2003). The predictability of an organisation's actions as a consequence of information sharing is important. It reassures other organisations that their assessment of that organisation's competence to participate in the supply chain can be maintained (Sahay 2003). This predictability plus the certainty that information received is of good quality improves supply chain performance (Strader, Lin & Shaw 1999).

The use of electronic communication gives the ability to transfer information in real time with minimal effort across an organisation's boundaries (Prem PremKumar 2003). A strong improvement in supply chain performance is possible by making available undistorted real time marketing data to participants in the supply chain (Towill 1997).

1.2.4 Electronic Data Interchange (EDI)

Within the timber industry, some organisations use Electronic Data Interchange (EDI) as a supply chain management tool (Meegoda 2003). EDI is currently being used in the Australian timber industry to exchange documents electronically, for example sales/ purchase orders, invoices and order acknowledgements (Meegoda 2003). Traditional EDI uses propriety codes and messaging standards. This means businesses make individual agreements between themselves to share data electronically in a prescribed structured format (Witte, Grunhagen & Clarke 2003). The use of these static agreements generates business overheads as the result of maintaining and using code maps, and subscriptions to Value Added Networks (VAN) that

provide communication services and security (Witte, Grunhagen & Clarke 2003).

Rigid messaging standards, high initial implementation costs, the need to restructure business processes and EDI operating costs have meant that only those companies who generate a sufficient volume of business with their trading partners, or have the available resources, can implement and gain the benefits of EDI (Senn 1998).

A standard library of elements that describes timber product attributes' would allow the industry to move away from a traditional EDI paradigm and discard the business overheads that meeting those standards entail. A new EDI paradigm is web-based EDI, which offers the advantages of EDI while negating some of the disadvantages. Web-based EDI does not require the use of a VAN or expensive EDI software but still requires a common understanding of data elements (Hasselbring & Welgand 2001).

1.2.5 Common understanding of data elements

An outcome of this study is the development of a prototype for a domain ontology consisting of a standard set of elements that describes timber and wood product elements. The ontology will be able to grow and develop as more organisations use the ontology in B2B communication. The ontology would be available to any timber industry organisation wishing to transact business electronically. This includes businesses that have not been able to

gain the business benefits from EDI due to a lack of resources, or volume of transactions.

An open standard will not force an organisation to use a specific technology or service. The standard will allow the documents to be formatted in an easy to read transmittible mode regardless of the technology used in the formatting. Use of the standard will bring equal benefits to the all parties of the transaction (Witte, Grunhagen & Clarke 2003). A standard set of names provides a simple inexpensive path to becoming an e-business partner (Downing 2002). The need for coordination between partners is reduced and the technology has a minimal impact on internal systems and processes. Web-based EDI has the potential to allow small to medium sized enterprises access to the advantages of EDI using low cost technology.

1.2.6 E-readiness

Although the Internet has the potential to succeed as a gateway to web-based EDI for small and medium sized enterprises, a level of e-readiness must exist in the industry for the diffusion of the technology to succeed. Web-based EDI for use in e-business is an innovation. Rogers (1995) identified a set of circumstances which expedite the adoption and success of an innovation. If an innovation is to be successful it must have the following characteristics:

- A competitive advantage is evident;

- The innovation can be efficiently and smoothly integrated with existing systems;
- It must mesh with how the organisation perceived itself;
- The innovation was not too complex; and
- Was trialable and could be observed in operation.

The Economist Intelligence Unit (2004) echo Rogers' (1995) claims with the comment that when the advantages of using the Internet are uncertain, the adoption rates will be low and will be influenced by the level of e-readiness of the environment.

E-readiness for a country is described by the Economist Intelligence Unit (2004) as a "measure of its e-business environment … that indicate how amendable a market is to Internet-based opportunities". The factors taken into account include a country's technology infrastructure, the general business environment, the percentage of businesses and consumers using e-business, the availability of e-business services and social and cultural conditions that impact on Internet usage.

Within the 64 countries measured, in 2004 Australia had a rank of twelfth, down from ninth in 2003. This drop in rankings is largely accounted for by the low percentage of broadband Internet penetration with just four per cent of Australians having broadband in 2004 (Economist Intelligence Unit 2004). The OECD broadband adoption rates for Australia measured in December 2004 showed 7.7 per cent (Organisation for Economic Co-operation and

Development 2005), indicating a rapid growth in adoption. In order to establish the level of e-readiness in the Australian timber and wood products industry a questionnaire was sent to a number of organisations in Australia from the industry.

1.3 Methodology

1.3.1 Questionnaire

The questionnaire was used to ascertain a baseline of how the industry views information systems and e-business now, the level of information systems infrastructure and knowledge present in the industry at present and the issues facing the industry now and in the future. The forestry and wood products industry is compartmentalised with no strong industry identity. There is little information on the use of information systems in the whole of this industry. This questionnaire will help to fill this gap (Forest and Forest Products Employment Skills Company Limited 2003).

The questionnaire was developed by the researcher using an initial set of questions designed to test the constructs which were refined by using a test panel to help eliminate inappropriate or ambiguous questions. The questionnaire was refined during a number of iterations before being accepted as final.

A characteristic of the Australian forestry and wood products industry is that it is spread over a large geographic area, made up largely of Small to Medium Enterprises (SME's) who have an unknown e-technology capability. The researcher felt that the channels of telephone and Internet delivery were unsuitable for the questionnaire and mail delivery was chosen.

The results of the survey were entered into SPSS and descriptive analysis carried out. Factor analysis was used to analyse two questions designed to test how an organisation views information technology and information technology governance and attitude. As a reliability check of the scale, Cronbach's alpha was calculated, with a measure greater than 0.7 being considered to have acceptable reliability (Gardner 2005).

1.3.2 Ontology

Ontology engineering has no set procedure to lay out an ontology. It has become accepted practice to use the Unified Modelling Language (UML) to represent the ontology visually. A list of all products was received from Hyne and Son Proprietary Limited and a UML diagram drawn to show the main categories and their relationships. An ontology engineering tool called Protégé (Stanford Medical Informatics 2005) was used to engineer the proposed ontology and generate a descriptive program.

1.4 Outline of the thesis

In the first chapter, the structure and the background to the thesis is discussed, along with justification and explanation of the research question. The research methodology frameworks used are summarised.
In the second chapter, the pertinent literature surrounding the research problem is discussed, with particular attention being paid to current Australian literature to maximise relevance. The areas discussed are information sharing, e-business enabling technologies, supply chain management and finally the semantic web. Information sharing in the Australian timber and wood product industry and the current state of knowledge of industry using ontologies, forms the first area. The e-business enabling technologies area includes a discussion of extensible mark-up language (XML) and its role in solving the problem of interoperability, followed by B2B e-business. The literature surrounding supply chain management is examined; this section includes background literature on supply chain management, and the advantages of an agile supply chain.

The importance of transparency of information within a supply chain, and its effect on the bullwhip effect and collaborative commerce and trust is discussed next. Electronic Data Interchange (EDI) is then discussed with the various aspects of EDI, including traditional and web-based access, being discussed in the context of interoperability. The last section deals with the

semantic web, including the common understanding of semantics, B2B frameworks for e-business and ontologies.

The approach taken and the manner in which both research methodologies were carried out is discussed in chapter three. The construction of the questionnaire, demonstrating the cycles of questionnaire construction to maximise reliability and validity is discussed followed by the care taken in gaining a representative sample. The steps taken in engineering an ontology are then set out and the required properties for an ontology highlighted.

Outcomes from the study are discussed in chapter four, with descriptive statistics on the Australian timber and wood product use of information systems and a discussion on whether organisational size affects attitudes to information technology, business-to-business communication, information systems security and information systems compliance to standards. A prototype of an ontology for the Australian timber and wood products industry is then presented.

The final chapter provides conclusions and implications drawn from the study. This chapter discusses the demographics of the Australian timber and wood products industry, what this means for the introduction of e-business, and how these organisations view information technology as an enabler of business strategy. Recommendations for the successful introduction of a system for automatic machine-to-machine communication are then reviewed.

1.5 Definitions

What constitutes a definition of a Small to Medium Enterprise (SME) is subject to some variation. For the purposes of this study, the definition in general use in Australia, that of an organisation employing under 200 employees, is used (APEC Centre for Technology Exchange and Training for Small to Medium Enterprises n.d.; Burgess 2003).

Definitions of other terms used in this thesis are presented in the accompanying glossary.

1.6 Delimitations of scope and key assumptions

1.6.1 Research Scope

The study is limited to those organisations previously identified in a study by the Forest and Forest Products Employment Skills Company Limited (FAFPESC). The developed ontology is a foundation for a common standard and is not intended to represent the needs of the whole industry. An information system designed to use the standard library of names for commercial transactions will not be designed or built.

1.6.2 Assumptions

The assumption was that timber industry organisations will allow access to product information for the purpose of research. This assumption was made

as the study is being carried out under the auspices of the Forestry, Wood Products Research Development Corporation (<http://www.fwprdc.org.au/>) and open access has been granted by Hyne and Son Proprietary Limited.

1.7 Conclusion

This chapter details the structure of the following thesis and introduces the background to the research. The research problems and issues are detailed, followed by the justification for the research, an overview of the methodology, and pertinent definitions and delimitations of the research are given. This chapter sets the framework for the subsequent chapters of the thesis with a comprehensive description of the research.

2.0 Literature review

This literature review comments on how e-commerce enabling technologies, such as the Internet, have impacted on B2B communication and supply chain management (SCM). The present state of information sharing in the Australian timber industry is discussed followed by examples of industries where a standard library of elements has been developed and implemented for B2B communication. Technology concepts and the need for interoperability which are driving advances in B2B communications are covered followed by SCM and SCM tools.

2.0.1 Information Sharing in the Timber Industry

Meegoda (2003) states that at present the use of EDI for supply chain management is not extensive in the Australian timber industry. This is due in part to high implementation and operating costs. These high costs are partly due to the use of propriety message formats and the necessity of using commercial intermediaries to provide formal translation services.

The timber industry e-commerce group (TIEG) is a group of industry representatives finding solutions for the e-commerce problems within the industry. This group is a subgroup of the Hardware Industry Work Group (HIWG) that was established as collaboration between industry stakeholders (Hardware Industry Work Group 2004). This work group has the objective of achieving supply chain efficiencies and cost savings through the

development and implementation of a standardised approach to B2B transactions. The committee has presented “The Australian Hardware Industry Guidelines for the Numbering and Bar Coding of Trade Items” (EAN Australia Ltd 2002) which details how to number and barcode items in the hardware industry with global identification numbers using the EAN•UCC system. This system is discussed in section 2.3.2.

The work done by the HIWG in defining some attributes of timber products is acknowledged, and a standard set of identifiers may be seen to extend and/ or offer an alternative to this work. It is proposed that the timber identifiers could be endorsed by the Standards Australia Institute as a timber industry standard, which is compatible with the global timber codes developed by the HIWG committee.

Examples of existing libraries of standard elements used in industry and built using XML, are the Marine Trading Markup Language (MTML), eXtensible Business Reporting Language (XBRL) and Agriculture (AgXML) (Goldfarb & Prescod 2004). These libraries demonstrate successful implementations of standard libraries of identifiers. MTML was derived from two existing standards for electronic data transmission which were already in use in the industry (Maritime e-commerce association 2002). AgXML designers working with industry members developed Unified Modelling Language (UML) use cases which are used to document a scenario of how a user will use the system. The business processes detailed in the use case act to highlight the required data elements which were extracted to form the

standard identifiers used in the library (AgXML L.L.C. 2001). A standard set of names for timber and wood product data elements has not been developed.

2.0.2 eXtensible Markup Language (XML)

XML's syntax is a subset of Standard Generalised Mark-up Language (SGML) and is a flexible data representation language (Benatallah, Rabhi & Mehandjiev 2003) which allows for a set of self-descriptive tags containing information about the data enclosed within these tags (Benatallah, Rabhi & Mehandjiev 2003; Dow 2001; Goldfarb & Prescod 2004; Hasselbring & Welgand 2001). XML is a simple text based language, which separates the structure and presentation of a document from its content. XML's advantages are that it is platform, language and technology independent while maintaining its extensibility and simplicity (Goldfarb & Prescod 2004; Ritter 2000).

A Document Type Definition (DTD) and schema are functionally equivalent, and define the structure of the XML document. The structure is defined by the DTD or schema, as they set out formal definitions for the element types, attributes, entities, notations and logical structure contained in a SGML document (Goldfarb & Prescod 2004). Use of a DTD or schema provides the means by which both sender and receiver interpret information contained in a XML communication (Goldfarb & Prescod 2004). Schema's and DTD's provide for robust processing of XML documents by providing input validation

services and standardisation of documents (Benatallah, Rabhi & Mehandjiev 2003; Microsoft Corporation 2003).

Document Object Model (DOM) or Simple Application Programming Interface for XML (SAX) provide a standard method for programs and scripts to access and update the content, structure and style of XML documents. Simple Object Access Protocol (SOAP) is a protocol used by XML to provide simplified, platform independent, distributed communication (Goldfarb & Prescod 2004).

The simplicity of XML is that at its core is a generic standard which allows other standards such as vertical industry standards or XML dialects to be integrated (Ritter 2000). XML dialects are used to define a common vocabulary, which can be expanded to provide an ontology of a specific domain (Fensel et al. 2002, p. 110). The ontology in conjunction with XML provides a framework for B2B communication facilitating automation transparently crossing organisational boundaries thus creating openness (Ritter 2000). XML also allows for the creation of a new electronic data interchange (EDI) paradigm, Internet or web-based EDI (Senn 1998; Witte, Grunhagen & Clarke 2003) and other advanced supply management tools.

2.0.3 E-business enabling technologies

E-business has been driven by a number of technologies, such as the Internet, world-wide-web, distributed computing environments and

middleware (Pease 2001). Communication standards and protocols are used to assist the interconnection of devices providing the required interoperability and enabling e-business (Dow 2001). The interconnection of devices can expand the scope of business and build stronger vendor relationships by allowing information to cross organisational boundaries (Rahman 2004). Rahman (2004) details how Internet technologies have increased the scope of business particularly in supply chain functions. However SMEs may not be aware of the opportunities made available by ecommerce and Internet enabling technologies (Mullins, Duan & Hamblin 2001).

The introduction of the Internet as a business channel has been recent, but its impact has been large (Shim et al. 2000). Schuette (2000) has described the Internet as becoming established in business in the same way as the telephone transformed the way that business is conducted.

Kang (1998) describes the Internet as a digital-information utility allowing transmission of digital information to anyone connected to it, with the value of the network increasing as the number of users increases. Organisations with a heavy investment in earlier standards may be reluctant to migrate to better standards due to the desire to maintain compatibility with the installed base (Kang 1998). Rahman (2004) details how Internet technologies have increased the scope of business particularly in supply chain functions.

Internet technologies have impacted on supply chains by increasing the speed of business, creating a business environment where fast decision making is the norm. Internet technologies provide a reliable and efficient network allowing system-to-system interconnections between suppliers and customers and removing technology barriers (Golicic et al. 2002). Organisations that initially used the Internet technologies to provide a visible web presence have now processed to moving functions of supply chain management to the Internet. The Internet provides advantages such as greater control, flexibility, and savings in business overheads (Yen & Ng 2003). Technologies such as EDI and product numbering have providing a means to link information flows with the physical flow of goods and services. The Internet provides a means to enhance current processes rather than providing just cost saving benefits, with the general expectation that the Internet will assume a greater importance as a means of B2B communication (Power & Sohal 2002). In the future Burt and Starling (2002) suggest a tightly integrated mesh like e-chain consisting of nodes, communications and seamless information transfer will be an essential part of business.

2.0.4 Business-to-Business E-business

B2B e-business comprises commercial transactions between one organisation and another organisation (Chaffey 2002). B2B e-business is considered to have larger impacts across the economy than business-to-consumer e-business. Typically, B2B e-business is about transforming the

back office functions of firms in order to allow the exchange of transparent information between trading partners.

E-business is when the organisation's business processes are restructured to take advantage of technology driven changes, to simplify processes, improve market share and drive profit growth (Kalakota, R & Robinson 2001, p. 2). It is this restructuring of business processes which forms the e-business platform, upon which B2B applications are built.

2.1 Supply Chain Management

Supply chain management can be defined as a set of tools and techniques applied to coordinate suppliers, manufacturers, warehouses and retailers so that goods and services are produced and distributed to the required locations within required service levels, while minimising logistics costs (Simchi-Levi, Kaminsky & Simchi-Levi 2003). Fawcett and Magnan (2002, p. 340) describe the ideal of supply chain management as managing from "the suppliers' supplier to the customers' customer ". Nurmilaakso, Kettunen and Seilonen (2002) sum up supply chain management as being about integration.

Management of the supply chain is done with the intent of improving customer service levels, reducing cycle time, and increasing inventory turnover leading to agile supply chains (Christopher & Towill 2000). Improvements in these functions increase the effectiveness of business

processes leading to improved organisational performance (Power & Sohal 2002; Prem PremKumar 2003). In the study conducted by Fawcett and Magnan (2002), 88 percent of all respondents rated supply chain management as a critical business strategy, due to its potential to contribute to organisational competitiveness.

Shorter product delivery cycles with global marketplaces have increased the demand for agile supply chains (Christopher & Towill 2000). Agile supply chains have made the need for good quality, timely information flowing across organisational boundaries through the supply chain a priority (Magretta 1998). Members of any supply chain regularly exchange electronic messages to co-ordinate business activities (Sánchez & Pérez 2003). Supply chain management is an organisational boundary crossing activity (Fawcett & Magnan 2002). This need for a flow of information across organisational boundaries has made agreement between trading partners on the meaning of exchanged information and interoperability of their information systems critical (Dow 2001; Hasselbring & Welgand 2001).

Electronic Data Interchange (EDI) has been a traditional tool for facilitating the information flow. Organisations have begun to form strategic alliances with trading partners, collaborating to compete as a supply chain rather than individually (Akkermans 2001; Barratt 2004; Hoyt & Huq 2000; Towill 1997; Walker 1994). Internet technologies have had an impact on business-to-business communication enabling the collaboration process (Pease 2001) and solving some problems in tools such as EDI. A key barrier to the

interoperability of business systems is the lack of an ontology which is an explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them (Gruber 1993a).

Optimising information flows requires interoperability along the supply chain and XML provides a means of providing the required interoperability (Hayashi & Mizoguchi 2003; Prem PremKumar 2003).

For example a manufacturer who can see a supplier's inventory may reduce the lead time for ordering, lowering inventory holding and reducing costs. Supply chain management works to lower lead times, cycle times and inventory holdings (Ayers 2001).

2.1.1 Agile Supply Chains

Agile supply chains were developed in response to a rapidly changing and dynamic business environment. The attributes of an agile supply chain are a minimal lead time with the ability to react to unpredictable market demand and satisfy required service levels (Bruce, Daly & Towers 2004; Christopher & Towill 2000). Stalk and Hout (1990) have shown that under some circumstances, end customers may be willing to pay a price premium for the fast response and ready accessibility to the right product that an agile supply chain delivers. Mason-Jones and Towill (1998) suggest that many

companies have gained positive results from focusing on improving response time to customer demand.

For a supply chain to attain the required agility it is necessary for demand information to be visible to the entire chain so that not just the echelon nearest the end customer is reacting to demand (Mason-Jones & Towill 1997). This demand information needs to be in a format which the entire supply chain can react to, with information technology being the driver to providing the capability of exchanging real-time demand information (Christopher & Towill 2000; Kalakota, Ravi, Stallaert & Whinston 1996).

The trading partners in the supply chain can plan production by forecasting the requirements of the next echelon up the supply chain or by reacting to their knowledge of current demand. Mason-Jones and Towill (1997) identify the major problem with planning production by forecasting as being that demand information suffers from delay and distortion as it moves through the supply chain. So that the further away is a member of the supply chain from the echelon with access to the real time demand data, the more likely it is that production planning does not reflect the actual demand.

When a supply chain member reacts to actual demand data to produce goods and services they are said to be operating as a pull-based supply chain as the data is being pulled from the end customers. A push-based supply chain plans production according to forecasts based on historical demand (Simchi-Levi, Kaminsky & Simchi-Levi 2003). The point at which a supply chain changes from push-based to pull-based is known as the push-

pull boundary (Simchi-Levi, Kaminsky & Simchi-Levi 2003) or the de-coupling point (Childerhouse & Towill 2000). The ideal in an agile supply chain is to have the de-coupling point as close to the start of the supply chain as practical (Childerhouse & Towill 2000).

2.1.2 Transparency of information in supply chains

Singh (1996) describes supply chain optimisation as a process where periodically (weekly or monthly) input data, for example inventory levels and demand forecasts, is studied, and an organisation wide optimisation plan produced. However as new data becomes available this plan may not precisely meet the organisation's needs so that the plan is adjusted by production and plant managers in an *ad hoc* fashion to their judged best plan given their available data. Towill (1997) states that the making available of undistorted, real time demand information to every echelon in the supply chains leads to a dramatic improvement in the performance of that supply chain. This improvement in overall supply chain performance is a competitive advantage in a market that Bruce, Daly and Towers (2004) argues competes on a supply chain to supply chain basis. Rahman (2004) describes this as competing on how well your supply chain is managed.

Mason-Jones and Towill (1998) describe demand information as the catalyst information for the whole supply chain with the best way to contract the information flow being to directly feed each echelon in the supply chain demand information. Childerhouse et al. (2003) suggest that it is crucial that

supply chain members have access to information of processes not under their control. While Stalk & Hout (1990) warn that data must be timely as data loses value as it ages with old data causing demand amplification, delays and overhead. The use of the Internet as a communication channel means that information has the potential to be broadcast to all participants in the supply chain at the same time increasing the speed of information dissemination (Angeles 2000).

Mason-Jones and Towill (1998) argue that while information technology is an important driver toward compressing the information flow, the focus must be on fidelity and availability of the actual demand data. Ayers (2001) states that no information is better than bad information. Kalakota, Stallaert and Whinston (1996) and Singh (1996) agree that in order for information to replace inventory the information must be accurate, timely, available and unambiguous. Organisations where access to timely demand information is available are able to make an informed decision earlier, dragging the push-pull boundary closer to the start of the supply chain (Mason-Jones & Towill 1998). Information which is distorted, missing or not timely leads to disruptions within the supply chain, extra costs and the bullwhip effect (Childerhouse et al. 2003; Mason-Jones & Towill 1998).

2.1.3 Bullwhip effect

The bullwhip effect is the situation where customer demand remains quite steady but inventory and back-order levels oscillate considerably (Simchi-

Levi, Kaminsky & Simchi-Levi 2003). Towill (1997) identifies the bullwhip effect as demand amplification. He states that in a five echelon supply chain the final upstream echelon may be affected by order swings as the demand is amplified by a ratio of 16:1 adversely affecting production capacity, inventory levels and costs. Forecasting is a predictive process which carries with it an element of uncertainty (Childerhouse et al. 2003). McCullen and Towill (2002) state that forecasting uncertainty is a major source of the bullwhip effect, with uncertainty being reduced by access to real time demand data. Lee, Padmanabhan & Whang (1997) also include as causes of the bullwhip effect order batching, price fluctuations and rationing when supplies are short.

Stalk and Hout (1990) discuss the need for each echelon in the supply chain to carry large inventory buffers to smooth out the oscillations of the supply chain. McCullen and Towill (2002) also include inventory swings and unnecessary fluctuations in the production levels and discontinuous supply of product, as a consequence of the bullwhip effect. In Stalk and Hout's (1990) opinion the cure for the bullwhip effect is timely information sharing with more frequent ordering intervals and reliable lead times supporting each other. Mason-Jones and Towill (1998) warn that while shorter lead-times improve any response to an increase in market demand, an outcome is that the system becomes more oscillatory. The bull whip effect may be mistaken for seasonality as oscillations in the upstream supply are caused by time delayed demand data (McCullen & Towill 2002).

McCullen and Towill (2002) suggest that the reason that the bullwhip effect has not been eliminated despite being identified and well understood is that capacity and inventory problems lag behind the event that caused the problem. Geographic isolation of upstream suppliers is a problem as the impact is felt far away from the originating source of the bullwhip effect. McCullen and Towill (2002) point out that in future with the increasing globalisation of supply chains the geographical distance between supply chain members may act to hide effects of the bullwhip effect and increase time delays.

Mason-Jones and Towill (1998) agree that successful agile supply chains must regard information as a competitive advantage ensuring that real time demand information is channelled through the supply chain with a minium of distortion. Lee, Padmanabhan and Whang (1997) identify EDI as a solution to encourage information flow with real time demand data amongst supply chain members. Kalakota, Stallaert and Whinston (1996) suggest that intelligent agents in a dynamic supply chain can act as a solution while other authors suggest information sharing and collaboration as a solution to the bullwhip effect (Childerhouse et al. 2003; Lee, Padmanabhan & Whang 1997; Mason-Jones & Towill 1998; Popp 2000).

2.1.4 Collaborative commerce

Emerging technologies for supply chain management are collaborative commerce, e-markets and Collaborative Planning Forecasting and

Replenishment (CPFR) (Turban et al. 2004). Collaborative commerce is made possible by web commerce, and means that any participants in the supply chain may work together regardless of their place in the supply chain. This characteristic of collaborative commerce tends to produce a supply chain which is not necessarily linear but may be more like a mesh network (Turban et al. 2004). Collaboration may be internal to the organisation as well as involving external organisations (Barratt 2004).

E-marketplaces are another alternative where a central location is available for suppliers and customers to meet to complete electronic transactions. An e-marketplace provides an alternative to supply chain management, but the same issues of interoperability apply (Prem PremKumar 2003).

Collaboration does not focus purely on the upstream supply chain but considers how to optimise the performance of the entire supply chain, so that decisions throughout the supply chain are driven by the end consumer demand (Ireland & Bruce 2000). Popp (2000) discusses how collaboration occurs when organisational boundaries are blurred as partnerships are formed, with Barratt (2004) adding that collaboration is a move away from an adversarial relationship between trading partners toward a win-win relationship. Adversarial relationships focus on price while collaborative relationships focus on the performance of the supply chain as a whole (Fawcett & Magnan 2002). Walker (1994) suggests that it is not until the exchange of in depth proprietary information such as demand data and forecasts that collaboration takes place.

Forming partnerships with suppliers is a means to obtaining best performance from the supply chain (Barratt 2004; Ireland & Bruce 2000; Wong 1999). Wong (1999) advocates the forming of a clear vision for the goals of the supply chain, describing co-operative goals as the glue in the relationship between supply partners. Collaboration has as a benefit, sizable cost reductions in total supply chain costs, but it must be limited to a few trading partners. It is not possible to collaborate with all suppliers as they form partnerships with other trading partners (Barratt 2004; Walker 1994). Barratt (2004) adds that limiting the number of collaborative partnerships to a few strategically important relationships is important is due to the resource intensive nature of the relationships. In true collaboration the supply chain acts as a single unit, with decisions being taken for the good of the supply chain (Fisher 1997; Simatupang, Wright & Sridharan 2004).

For collaboration to succeed it is necessary for the relationships to be built on a basis of trust and commitment (Fisher 1997; Spekman, Kamauff & Myhr 1998). Fliedner (2003) details some obstacles to collaboration and CPFR as being lack of trust in sharing information, availability and cost of technology and expertise and fragmented information sharing standards. He adds that synchronising how the metrics of the supply chain are captured and methods of compatible data interchange are important issues. Standardisation of electronic connections across a number of trading partners is an important factor in keeping connection costs low adding to success factors of a project (Christiaanse & Markus 2003). Hasselbring & Welgand (2001) state that for organisations to exchange information they must agree on the form of

information messages and define the meaning of the information. Collaboration may be driven by technical partnerships such as EDI (Walker 1994) which provides a vehicle for integration activities (Sánchez & Pérez 2003).

2.1.5 Trust

Trust is an important component of the relationship between participants in the supply chain (Hoyt & Huq 2000; Sahay 2003; Schneider 2003). Trust contributes to the long term stability of relationships and is viewed as the willingness to not undertake opportunistic behaviour (Spekman, Kamauff & Myhr 1998). Golicic et al. (2002) discusses how committed relationships provide a long-lasting advantage, as commitment and trust provide a safeguard against competitive organisations in the market.

Schurr and Ozanne (1985) declare that trust is the certainty that a party's word or promise is dependable and that the party will fulfil their obligations in an exchange relationship. Communication and information sharing is an important facet in building a level of trust between trading partners (Schneider 2003; Spekman, Kamauff & Myhr 1998) as trust reduces uncertainty in another organisation's actions (Sahay 2003). Popp (2000) declares that communication both supports and encourages trust. Building trust allows the development of non-adversarial relationships between trading partners. The predictability of an organisation's actions as a consequence of information sharing is important. It reassures other organisations that their

assessment of that organisation's competence to participate in the supply chain can be maintained (Sahay 2003). This predictability plus the certainty that information received is of good quality makes possible the improvement of the supply chain performance (Strader, Lin & Shaw 1999).

Ratnasingam (2002) describes the need for technology trust where an organisation needs to be able to trust that the information systems of a trading partner are equal to the demands of the linkage made, and that policies such as security are adequate.

2.1.6 Electronic Data Interchange (EDI)

EDI is one type of B2B e-business which allows the internal system of one business to transact with the internal system of another business for the exchange of electronic documents (Hasselbring & Welgand 2001). The technology is designed to replace the expenditure, effort, and time incurred by paper-based business transactions (Shim et al. 2000). Senn (1998) describes EDI as a favoured technology for implementing interorganisation systems. EDI has been shown to produce error free current information, while handling a large volume of transactions eliminating some clerical tasks by automation of those tasks (Lu & Wu 2004; Strader, Lin & Shaw 1999; Turban et al. 2004; Witte, Grunhagen & Clarke 2003). The automation of tasks gives EDI the ability of speeding up information transfer (Lu & Wu 2004). EDI is an important element in allowing business-to-business

ecommerce to take place with Angeles (2000) declaring that EDI is one of two building blocks, the other being electronic payments .

The diffusion rate of traditional EDI has been slow (Angeles 2000; Senn 1998) despite its advantages, due to the cost of implementation and the balance of power skewed with one organisation dictating trading terms (Angeles 2000). In Jun and Cai's (2003) study, 66 per cent of respondents indicated that they were forced to adopt EDI by their trading partners which showed a lack of management buy in to the benefits of EDI by the respondents. Jun and Cai (2003) state that previous studies have shown that the EDI initiator usually obtains the majority of the benefits, however Prem PremKumar (2000) states that in the long term all parties benefit.

Senn (1998) describes the disadvantages of traditional EDI as the need for a large initial resource investment, the need to restructure business processes to work with EDI, the number of agreements between different organisations that must be made, and ongoing operating costs. Shim et al. (2000) adds that different EDI standards are used dependent on the country of origin, making international transactions complex. Jun and Cai's (2003) study showed that a lack of organisational readiness for EDI and trust were factors in EDI implementation failures.

Mullins, Duan and Hamblin (2001) state that costs associated with EDI have been a major barrier to EDI adoption by SMEs with some SMEs viewing EDI as a cost of doing business rather than a strategic advantage (Jun & Cai

2003). Senn (1998) adds that the full potential of EDI systems will not be realised until a larger proportion of organisations are able to participate. In a survey undertaken in 2005 of a sample of the Australian timber and wood products industry, it was found that 92% of the respondents belonged to organisations consisting of fewer than 100 employees and so can therefore be classed as SMEs (Blake & Pease 2005b). It can be concluded that cost of traditional EDI has formed a barrier to the adoption of EDI in the industry (Blake & Pease 2005a).

Traditional EDI requires trading partners to agree on message standards which dictate the structure and content of the message, with two well known standards being ANSI X.12 which is used mainly in North America and UN/EDIFACT used in the rest of the world (Lu & Wu 2004). Trastour, Bartolini and Preist (2002) describe the necessity for agreement as "locking in", as trading terms and conditions were locked in as part of the agreement. Traditional EDI involves the use of a Value Added Network (VAN), an intermediary communications network which charges trading partners for the use of the service. A VAN provides a secure environment for transactions, with the ability to translate between standards used by the trading partners (Awad 2002). This process must be repeated with all EDI trading partners.

Due to the close collaboration needed to generate agreement on the message standards and translation software, EDI has been restricted to trading partners with a high volume of transactions and scale of operation as implementation costs are high (Hasselbring & Welgand 2001; Senn 1998;

Witte, Grunhagen & Clarke 2003). Hasselbring and Welgand (2001) detail that the rigidity of the agreed upon message standards do not allow for the introduction of new products and services without going through a negotiation phase with trading partners or the introduction of new business rules. The interface between trading partners must remain perfectly synchronised with reliance that changes in one side will be reflected in the other by maintenance staff (Hasselbring & Welgand 2001). This implies a level of technical expertise and staff resources which may not be available to a SME.

2.1.7 Web-based EDI

Senn (1998) argues that due to traditional EDI's reliance on formal individual agreements, translation software and VANs, it is not an enabling technology for long term interorganisation systems. Barriers to traditional EDI's use mean that SMEs and large organisations that do not place a large volume of orders are not able to justify the amount of resources necessary to use EDI (Fu et al. 1999).

The World Wide Web was developed as a data repository, allowing users in separate locations to collaborate on common undertakings (Berners-Lee et al. 1994). Web-based EDI uses the capabilities of the World Wide Web and Internet technology as a low-cost, publicly accessible network with ubiquitous connectivity, which does not demand any particular network architecture (Goldfarb & Prescod 2004; Senn 1998). Web-based EDI offers an opportunity to participate in EDI at a cost three to ten times cheaper than

traditional EDI (Wilde 1997). Angeles (2000) describes the utilisation of the Internet as an EDI channel as leading to the democratisation of ecommerce

XML, discussed in section 2.0.2, is a web-based language which maintains content and structure, but separates business rules from content (Goldfarb & Prescod 2004). XML identifiers and syntax are used to structure electronic documents, and those documents are sent through the Internet. The use of XML means that messages do not have to be as highly structured, with the length and sequence of attributes able to be varied. This flexibility makes agreement on electronic business standards between trading partners easier to negotiate (Hasselbring & Welgand 2001). One of the benefits of XML is that everyone in the supply chain can work with the original data with no need to reinterpret the data at each echelon of the chain to match individual data-types (Dow 2001).

Downing (2002) found that organisations using web-based EDI reported a higher degree of improvement in their overall performance when using information technology, and rated long term commitment with their suppliers as higher than those organisations with no EDI or traditional EDI. The Nurmilaakso, Kettunen and Seilonen (2002) study compared traditional EDI with a XML based integration system designed to support EDI and they found that the implementation costs of traditional EDI were much higher, with the cost of establishing a new message type three to four times higher.

Web-based EDI offers an alternative to traditional EDI implementation and also provides the means to complement current EDI arrangements (Senn 1998; Shim et al. 2000). XML and web-based EDI can broaden the scope of supply chain integration by including those organisations that are not willing or able to justify the resources necessary for traditional EDI (Nurmilaakso, Kettunen & Seilonen 2002). The introduction of web-based EDI offers the opportunity for a mature EDI architecture where current EDI can be integrated with web-based online transactions (Moozakis 2001). Those organisations that currently use traditional EDI have the opportunity to save costs using web-based EDI to bypass the use of a VAN (Angeles 2000) with Internet technologies providing the necessary interoperability.

When a standard set of elements is developed for an industry, if the data meets the requirements of the DTD or schema then it will be accepted by the trading partners system (Witte, Grunhagen & Clarke 2003). This means that trading partners can exchange electronic documents such as orders irrespective of their internal systems, and no negotiation needs to take place before EDI transactions occur, lowering implementation costs (Hasselbring & Welgand 2001).

2.1.8 Interoperability

In business-to-consumer (B2C) ecommerce the requirement is for the business to interface with a small range of web browsers so interoperability is not a major concern. However in B2B ecommerce a business is required to

interface with a diverse complex range of technologies making interoperability a priority (Shim et al., 2000). Interoperability is the ability of two or more systems to exchange information and to use the information that has been exchanged (Awad, 2002). Prem PremKumar (2003) states that in order to overcome interoperability problems it is necessary to use third party intermediaries such as VANs thus adding to the operating costs, or establish an open information system architecture that can exchange messages irrespective of hardware and software.

The existence of open standards is a vital factor in promoting interoperability (Department of Communications Information Technology and the Arts, 2004). An answer to the integration problem is the use of Internet technology, protocols such as Hyper Text Transfer Protocol (HTTP), and common data exchange languages such as eXtensible Markup Language (XML) (Dow, 2001; Goldfarb & Prescod, 2004).

Murtaza and Shah (2004) make the point that an organisation which chooses to use XML for its internal systems has already dealt with the need for interoperability. They go on to state that XML based web-services can provide an uncomplicated path for low-cost efficient interorganisation systems. General approval of web services and its associated protocols have meant that this is a well defined path for interoperability (Murtaza & Shah, 2004).

2.2 Ontologies and the semantic web

Tim Berners-Lee (Updegrove 2005) presents the semantic web as an evolution of his original vision of the world wide web, so that the semantic web will exist as a layer upon the existing e-technologies. He describes the web as only achieving its full potential when data can be shared and processed by automated tools (Carvin 2004). The goal is to construct an environment where semantically annotated web sites using ontology based mark-up are accessible and readable by machines, for example intelligent agents and information filters (Decker et al. 2000). The semantic web offers not only the ability to search by key word but also context, moving the World Wide Web away from being a presentation medium for people and enabling machine to machine interactions (Siorpaes 2004; Updegrove 2005).

To achieve this, the semantic Web must contain machine readable metadata describing the data, relationships and the knowledge domain of trusted sources. Defining metadata of a domain to give a shared understanding of data elements results in a domain ontology (Colomb 2005). If a group of systems is going to interoperate and exchange messages, then the organisations responsible for the system must agree on the meaning of words and messages in the interoperation. These agreements to overcome problems of semantic heterogeneity and removing ambiguity from intended meaning, are called ontologies. The interoperation of more than one information system requires independent information structures outside the interoperating system (Fensel et al. 2001).

An ontology is an explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them (Gruber 1993a).

An ontology can be represented as a hierarchical data structure showing the data entities and their relationships and rules, and this data structure can be represented in a language which is often based on XML, such as Resource Description Framework (RDF) and Web Ontology Language (OWL) (Colomb 2005). The ontology describes each data entity's critical properties through an attribute value mechanism. The ontology description languages do not have a standard modelling tool to show a graphical representation of an ontology fragment. As discussed by Colomb (2005), Unified Modelling Language (UML) can be used to provide a visual representation of a portion of an ontology.

Formal upper ontologies which define general non-domain specific entities that exist in reality, such as creator and date which are both defined in the Dublin core metadata initiative (DCMI 2005), are imported. Degen et al. (2001) postulate that every domain specific ontology must import an upper ontology to use as a framework for concepts which are broader than the domain specific ontology. The Bunge-Wand-Weber (BWW) system defines a number of concepts for data entities or classes such as *Thing*, *Things* have *properties*, *Things* have *states* and *Coupling* (Rosemann & Green 2000). There are a number of other upper ontologies such as the DOLCE system

(Gangemi et al. 2002), importing these ontologies into an information system using a domain specific ontologies' act to introduce richness into the definition of the world described in the ontology (Colomb 2005).

Thomas Gruber introduced the theory that the quality of an ontology could be evaluated using five objective concepts. These principles are:

- Clarity
- Coherence
- Extendability
- Minimal encoding bias; and
- Minimal ontological commitment

(Gruber 1993b).

Clarity in an ontology requires that the meanings behind the terms defined should be unambiguous and objective so that the organisations sharing the ontology understand the intended meaning of the data entities contained within the ontology. Definitions should be formal to restrict the number of unintended meanings (Gruber 1993b).

The explicit associations between data entities can be detailed to support the clarity of the ontology. Associations such as cardinality constraints, *part of* associations and coupling can be introduced. Cardinality constraints can be introduced between data entities to make the requirements for an element explicit to organisations committing to an ontology. For example element A must be associated with only one element B.

The concept of a *Thing* having a property *part of* derived from the Bunge-Wand-Weber formal upper ontology makes clear the association between data entities. This helps to make an implicit relationship between classes explicit, clarifying that sub-classes form *part of* the *whole.* A class can be defined as describing the structure and behaviour of a set of objects which are its instances (University of Bath, n.d.).

It assists the quality of clarity, if in the class hierarchy of an ontology, the sub-classes that have been declared are defined. A defined sub-class means that a *Thing* belongs to a sub-class because of a predicate on the superclass of the sub-class (Colomb 2005), in a declared sub-class a *Thing* belongs to that sub-class through a subjective judgement. A defined sub-class reduces the number of unintended meanings drawn from the ontology.

Coherence is the consistency of the rules applying in the ontology so that software can carry out the reasoning contained within the ontology. So circular references must be checked for, inferences assumed in the conceptualisation must be made explicit.

Extendability is making allowance for an extension of the ontology at some time in the future; this involves eliminating redundancy and trying to isolate future areas of variability. This is the same principle as database normalisation (Colomb 2005).

Minimal encoding bias should exist so that the ontology is implemented at a knowledge level not at the implementation level. This means that the inner workings or implementation are not dictated but left up to the user as long as the correct actions in the environment are produced (Colomb 2005; Gruber 1993b).

The last quality concept specified by Gruber is minimal ontological commitment. Ontological commitment is the extent to which the agent must give up autonomy in order to make their actions consistent with the ontology. Gruber (1993b) states that ontological commitment is the agreement to use the ontology in a manner that demonstrates its actions are consistent with the definitions in the ontology.

2.2.1 Common understanding of semantics

The development of a common global standard will facilitate and hurry the transition from traditional paper-based or inflexible methods to ecommerce methods (Mulligan 1998). Hasselbring and Welgand (2001) describe the need for the standardisation of message formats and meanings of the messages as a barrier to the wide-scale adoption of e-business. The use of XML and technologies such as web services help to solve the technical demands of interoperability but there is a need for descriptions of products and services to share common semantics (Trastour, Bartolini & Preist 2002). Interoperability of information systems does not solve the problem of differences that organisations have in their representation of things in their

system, such as products, relationships and units of sale. An example of this within the Australian Timber industry is where one organisation defines a pack of timber as a number of linear metres, while another organisation considers a pack to be a set number of pieces of timber, leading to semantic heterogeneity (Colomb 2005). Dow (2001) talks about common vocabularies or ontologies bringing the same benefits as the small number of tags whose meanings are known, brought to HTML.

The ontology provides the means for multiple users or multiple organisations to straightforwardly share data and to unambiguously understand that data. In traditional EDI this facility was provided by the use of coding systems such as UN/EDIFACT. The move to Internet based EDI does not negate the need for the shared understanding of the meaning of data elements and their relationships (Reimers 2001). An open standard for the Australian Timber and Wood Product industry consisting of an ontology provides the means for cross institutional data exchange without having to be concerned with the trading partner's internal representation of products. The organisation will have to commit to the ontology, foregoing some autonomy, but they do not have to commit to mapping to other organisations' representations (Colomb 2005). This provides the means for the organisation to introduce loosely coupled connections between trading partners. These loosely coupled connections remove a dependence on a trading partner's information systems and the technical burden of maintaining multiple EDI systems.

2.2.2 Business-to-business frameworks for e-business

One approach to achieve interoperability in the B2B e-business domain where there is a requirement for the automation of transactions is to develop B2B frameworks typically using XML. The frameworks provide a standard means of electronic communication between organisations using the same standard (Shim et al. 2000). Examples of the frameworks are RosettaNet, Electronic Business using eXtensible Markup Language (ebXML), Australia's BizDex (Standards Australia International Ltd 2003)and the coding system EAN•UCC (EAN Australia 2004).

RosettaNet was formed in 1998 as an independent consortium working to create e-business standards for the global supply chain (RosettaNet 2004). The RosettaNet consortium provides interoperability by focusing on three areas, being a technical and business directory, implementation framework and the specification of business processes (Partner Interface Processes). The Technical and business directory defines the meaning of a message ensuring unambiguous understanding between trading partners. The implementation framework defines the protocols and technical framework necessary to exchange messages. The Partner interface processes specify the processes and data elements used in transactions (Benatallah, Rabhi & Mehandjiev 2003; Shim et al. 2000). Using the Partner interface processes' guidelines as a technical blueprint, organisations may quickly develop interfaces to exchange electronic transactions. RosettaNet is based upon the Open Buying on the Internet (OBI) e-commerce standard (Shim et al.

2000). OBI was developed in 1997 as an open flexible standard for B2B Internet commerce for simple transactions. OBI was not designed for global commerce and lacks the facility to cope with pre-purchase and post-purchase business processes (Luster et al. 2000).

ebXML is a framework for e-business based upon XML. ebXML's development was started in 1999 by the Organisation for the Advancement of Structured Information Standards (OASIS) who planned a five layer data specification. The layers are for business processes, core data components, collaboration protocol agreements, messaging and registries and repositories (ebXML.org n.d.). Peng, He, Li and Liu (2004) describe ebXML as a set of specifications for a global e-business marketplace where organisations can conduct business through the exchange of XML-based messages.

A scenario for ebXML is shown in the figure below (Figure 1)

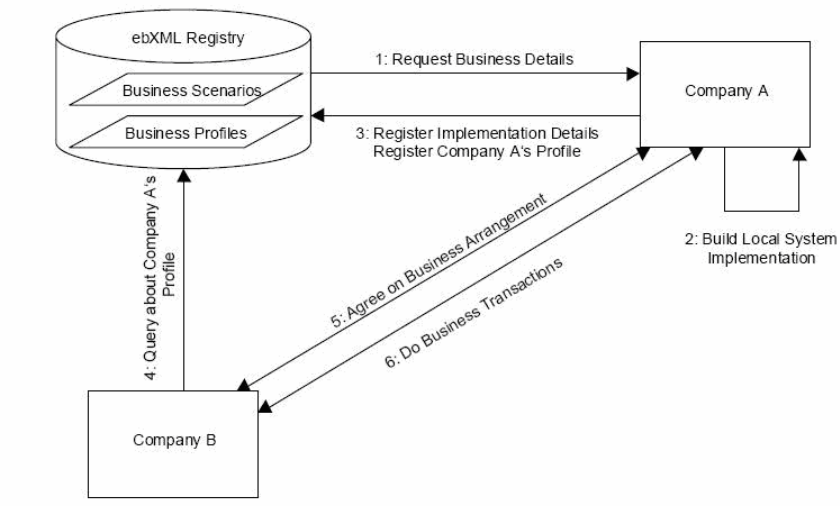

Figure 1. ebXML scenario
(Source: Hofreiter, B, Huemer, C & Klas, W 2002, 'ebXML: Status, Research Issues, and Obstacles', paper presented to 12th International Workshop on Research Issues in Data Engineering: Engineering E-Commerce/E-Business Systems, San Jose, California, February 24 - 25, 2002.)

In this scenario Company A requests business details from the ebXML registry and then builds its own ebXML compliant local system. Company A then submits details about its organisation, capabilities, business processes and supported business scenarios. Company B, using an ebXML complaint application, then discovers Company A's capabilities maintained in the registry. Company B then sends a request to Company A stating that they would like to engage in a business scenario and submits a proposed business arrangement to the interface provided by Company A's ebXML software. Company A must accept the agreement and the organisations may now conduct e-business using ebXML (Hofreiter, Huemer & Klas 2002).

The use of ebXML provides a framework and tools for e-business to be conducted but there still must be agreement between the organisations on business semantics. This facility is provided by the core component layer which provides for an organisation to view a potential trading partner's core components and develop software components to access the core components of supported business processes. Hofreiter, Huemer and Klas (2002) suggest that it is necessary to research support for interoperability between e-business vocabularies or develop domain specific ontologies. Although ebXML does not provide a solution to semantic heterogeneity between trading partners, it does provide an interoperability solution for the B2B domain (Patil & Newcomer 2003).

BizDex is a national interoperability standard designed to promote business-to-business e-business in Australia. BizDex leverages the capabilities of the ebXML frame work to provide this capability. The concept behind Bizdex is to reduce the implementation costs of providing for cross business interoperability and application to application integration. The lowering of costs is to facilitate making the benefits available to small to medium enterprises and organisations with low transaction flows (Standards Australia International Ltd 2003). BizDek provides an Australian framework for e-business which has been built to enable SME's to gain access to the benefits of automated electronic document exchange, however agreement on semantics must still be negotiated.

The EAN•UCC system is most visible as the bar codes on goods. The system is made up of three components, standard numbering structures, data carriers (for example bar codes) in a machine readable format and eMessaging standards. It is a set of coding rules for the assignment of a unique Global Trade Identification Number (GTIN) and its representative machine readable bar code. These numbers provide for the "unique identification of all trade items, processes, services, shipments, assets, companies and locations at any point in the supply chain". The GTIN number may be used for a single item or a "standard and stable grouping of items". The EAN•UCC system is administered by EAN International in Brussels and is a global standard so that EAN•UCC coding has the potential to be recognised by world wide trading partners. The GTIN has the capacity to not only identify the product but also capture attributes such as weight, serial

number and a best before date. The barcodes may then be scanned to retrieve the encoded information (EAN Australia 2004).

The Hardware Industry Work Group is a steering group of a hardware industry B2B e-business project to achieve supply chain efficiencies and cost savings through the development and implementation of a standardised approach to B2B transactions. There are four sector groups, one of which is the Timber Industry E-commerce Group (TIEG) (Hardware Industry Work Group 2004). A set of standards has been developed by the TIEG for the identification of timber and wood products using the EAN•UCC system (Tom 2002).

In these recommendations a GTIN is assigned at the product and packaging level, so that the same product sold by piece, bundle or pack would have a unique GTIN dependent upon how the product is packaged. It is recommended that the onus is on the customer to use the GTIN that most fully defines the item.

A possible problem with the GTIN which is both product and packaging specific is that an organisation may use its own product coding internally meaning that mapping must take place between the external GTIN coding and the internal coding. Substitution of similar goods for ordered goods is also common in the timber industry, requiring the GTIN to be changed. This means that a customer's system must be tightly integrated with a supplier's, imposing implementation and maintenance costs.

Another potential problem with this approach is that different wood product mills commonly produce different size packs of the same timber and these packs are generally regarded as the same product, so that different pack sizes are substituted freely for each other. This creates a problem in that the customer must know from which mill a pack of timber is coming to use the correct GTIN. A later amendment "The implementation of fixed and variable measure GTINs for set length packs" (Tom 2003) makes an interim provision for this problem by stating that a generic GTIN for the product may be used for ordering as long as the correct GTIN is bar coded on the packs. The expectation is that in time the mills would move toward standardising the pack size negating the need for a generic GTIN (Tom 2003).

An alternative to having a third party EDI provider is for all trading partners to agree to a single identifier or a code for each product. For example this could be a 'Global Timber Code' for the timber industry. Each trading partner, when sending an EDIFACT message, could then use this global code in all transactions. They can continue to use their own (existing) product code internally while using the 'global code' when ordering. This way each trading partner would have a mapping table that would map their own product codes to the 'global code'.

The creation of a global code would eliminate many problems by providing a consistent ordering process across the industry. This way, any new customer or a supplier would also have no problem in becoming a trading partner at any time. Defining a format for a global code that the industry is

prepared to accept is difficult. There are concerns that a global timber code would "commoditise" timber products, and make redundant the marketing strategy of branding and packaging the same or similar products in many different ways (Meegoda 2003). A global code would act as a taxonomy, but lacks an ontology's ability to describe a conceptual relationship and provide a stepping stone to the Semantic Web.

The literature survey has shown that in order to achieve effective information interchange between SME type organisations where a lower volume of messages is generated, it is required that the following characteristics exist:

- A standard range of flexible messages
- Low cost implementation
- Low technical expertise requirement
- Low cost maintenance

The above frameworks for B2B e-business all suffer difficulties in meeting the constraints imposed by the SME environment. A domain specific ontology for the Australian timber and wood products industry would provide a solution to the problem of semantic heterogeneity and would allow a B2B framework aimed at SME's, such as BizDex to be used within this environment.

2.3 Conclusion

The implementation of business-to-business information systems has traditionally been available only to organisations large enough to have substantial technical and financial resources. Cross institutional information flow is important in supply chain management with the exchange of

transparent information facilitating collaborative commerce. Collaborative commerce builds an environment in which organisations including SME's can compete as a virtual organisation or value chain. Information is transparent when an agreement on the semantics of the information is reached between trading partners. Traditional EDI with its rigid structure has been a solution to gain advantages of cross institutional information flow, but this solution can only be used between organisations exchanging large quantities of data, and the use of third party value-added networks. Web-based EDI offers a lower-cost, less technology intensive path to information sharing, but despite the use of XML, agreement on semantics is still an issue. Current research into ontologies and the semantic web, suggest that industry agreement on an ontology will encourage cross institutional information flow, without the necessity for dedicated technical staff.

The Australian timber and wood products industry, as discussed in section 2.0.1, largely consists of SME's who due to existing barriers have been unable to benefit from information sharing. The researcher was unable to find any literature on the barriers in this industry, hence the industries' level of acceptance of e-commerce and their level of expertise in information systems was unknown. The introduction of a domain specific ontology provides a pathway for industry wide agreement on semantics and therefore sharing of transparent information. In order that the introduction of an ontology has a possibility of being successful, a questionnaire to establish a base level of the industry usage of information systems and openness to the diffusion of new technologies, was decided upon.

3.0 Methodology

The study is descriptive in nature. Descriptive studies create a representation of a situation, and allow a set of categories to be formed or type classification to be carried out. A mixed or integrated methods' approach was employed, using both qualitative and quantitative methods. Qualitative research and quantitative research can lead to a deeper, more integrated study, using the strengths from each method to complement each other (Neuman 2003).

3.1 Introduction

An account of the approach to undertake the research in this study is presented in section 3.2. The sample and construction of the questionnaire is presented in section 3.2.1, followed by considerations taken into account in the engineering of the ontology using Protégé in section 3.2.2. Ethical considerations are discussed in section 3.3, followed by a conclusion in section 3.4.

3.2 Research procedures

3.2.1 Questionnaire

There is a lack of an information gathering point for this industry such as a central organisation that covers the forest and wood product industry in

Australia. This has made compiling a list of forest and wood product organisation addresses difficult. To gain a sample from the most complete data resource available, it was decided to use an existing industry database which gathered data on the target population (Zikmund 2003).

The Forest and Wood Products Research and Development Corporation (FWPRDC) commissioned an industry data collection survey to gain a central data resource, which the Forest and Forest Products Employment Skills Company Limited (FAFPESC), carried out. This survey was designed to capture information about the industry from the growing of trees to the manufacture of sophisticated end products. One of the objectives of the study was to develop and maintain a database of industry appropriate data, including names and addresses of industry members (Forest and Forest Products Employment Skills Company Limited 2003).

FAFPESC used a Participatory Action Research (PAR) approach to the collection of data as they felt that PAR provided the means for better communication and ownership of the project by industry members. Wadsworth (1998) defined PAR as “action which is researched, changed and re-researched, *within* the research process by participants”. FAFPESC used all their available contacts to prepare a list of industry organisations, collected from industry, government and commercial sources. Only those organisations with contact telephone numbers were included in the FAFPESC study, a total of 14 900 organisations. These organisations’ contact details were verified by a call centre organisation, Strahan Research.

FAFPESC initially received a 7.75% return rate, increasing this rate to 30% with a free telephone number for returned calls and up to three calls per enterprise. One of the results of the survey was a database of 12 000 individual sites undertaking processes that brought them under the Australian timber and wood product sector.

FAFPESC's report details the problems they faced in surveying the timber industry including:

- A lack of a strong industry identity
- Lack of meaningful responses to the full questionnaire
- An unwillingness to contribute unless there was a direct benefit
- A lack of existing industry and enterprise information
- Competition between industry associations, sectors and states

Due to the effort expended by FAFPESC to build a complete industry database, they were asked to supply mailing addresses for the surveys. Therefore while the target population was all organisations in Australia that carried out operations and processes that involved being part of the Australian timber and wood products industry, the working population being surveyed was the 12 000 organisations held in the FAFPESC database, with population being defined by Zikmund (2003) as the complete group of *things* that share some set of characteristics. It was decided to accept the FAFPESC definition of an Australian timber and wood product organisation as establishing this was another outcome of their research project (Forest and Forest Products Employment Skills Company Limited 2003). The

FAFPESC (2003) conclusion is that a timber and wood product organisation fits into one or more of the following sectors:

1. Forestry growing and management
2. Harvesting and haulage
3. Sawmilling and processing
4. Timber products manufacturing
5. Wood panel/ board production and manufacturing
6. Pulp and paper manufacturing
7. Timber merchandising

Sampling frame error was introduced by the decision to use this working population due to the reliance that organisations be members of the sources explored by FAFPESC (detailed above) which means that organisations self selected themselves as belonging to the industry sectors detailed. As the industry is heterogenous, organisations may not see themselves as part of the industry, for instance this researcher spoke to a furniture manufacturer who received a survey, but who said that their organisation was not part of the industry despite a heavy reliance on wood products as a raw material.

The literature was searched for an existing instrument to test the constructs, but this was not found. The development of the instrument contained in Appendix A was carried out in stages. A list of potential questions was constructed. These questions ranged from documenting the organisation's perceived sector, and number of branches, through the extent of use of communication technologies, to the organisation's attitude to information

technology. The initial list of questions was checked by the researcher and three other colleagues to ensure that the constructs covered were those listed in the research question. At this stage a number of potential questions that were not directly on topic were discarded. The second stage involved checking the wording of the questions, for ambiguous or poorly worded questions and proof reading for errors. The questions were again checked by three colleagues and the questions changed for better understanding by the respondents. The order of the questions was looked at to encourage response (Zikmund 2003). Demographic information and data on the respondent was gathered in the first page of the questionnaire, with open and closed response questions following on subsequent pages. A flow chart was drawn to check that the included filter questions, for instance “Does your organisation have Internet access” directed respondents through the correct channels of the questionnaire (Zikmund 2003). The final questionnaire was checked by the same three colleagues and three non-academics for final proof-reading.

It was decided to use a mail survey due to the widespread geographical nature of the respondents, large number of SME’s who would not be available during business hours and the lengthy nature of the questionnaire. The questionnaire was ready to be sent in November 2004, but the timing of the survey so close to Christmas was a concern as it was felt that this would negatively impact on the return rate as potential respondents may not have had time to complete the questionnaire. The questionnaire mail out was delayed until February 2005 to maximise the return rate.

A cover letter was attached stating the importance of the study to the Australian timber and wood industry and giving contact details for the researcher to answer any questions. A self-addressed envelope with return postage was included, to further increase response rate (Leedy & Ormrod 2001).

A sample size of 2 000 was decided upon, as in line with FAFPESC comments a low return rate was anticipated. FAFPESC attained a 31% return rate only after 2 mail outs, up to three follow-up phone calls and providing a toll-free telephone number, but this level of support was not possible for this survey due to the time and financial constraints of the study. The number of surveys returned was 242, which is a 12.1% return rate. It was decided to enter the data gained to see if the results attained were in broad general agreement with the Australian Bureau of Statistics (2005b) survey. The results were in general agreement as detailed in chapter four.

An Access database was built to receive the results of the questionnaire, with forms echoing the questionnaire for data entry. Coding of the questionnaire was carried out at this stage and dummy data was entered to check that the coding was exhaustive and the data was displayed in the required formatting. Coding of the open-ended questions was not carried out, as the classification of the answers could not be carried out until the data was received. Code creation for the open-ended questions in the questionnaire and data reduction was carried out by analysing these documents and drawing out

themes or clusters of ideas which were stored as an annotated document. The themes or clusters of ideas were indexed by the coding system to allow a final comparison/ contrast analysis (Huberman & Miles 1994). This activity was subjective and reflected the judgement of the researcher.

The structure of the data was checked using dummy data to confirm that the data could be imported into SPSS v12.0.1 for data analysis. The data entry was carried out solely by the researcher involved using the forms built in Access that was patterned after the questionnaire to aid accuracy (Zikmund 2003).

3.2.2 Ontology

Hyne and Son Proprietary Limited is a large organisation employing over 850 employees. The organisation has an extensive product listing covering a broad range of timber and wood products, and offered access to and help with their product listing. The organisation also maintains a considerable investment in B2B communication and is interested in exploring alternative channels of B2B communication. For these reasons it was felt that the product listing would provide a suitable basis for the extraction of base elements of an ontology.

The product listing was arranged in characteristics. Each of the characteristics is assigned a code, which are appended together to construct a meaningful code to describe the timber product. These characteristics

were separated into classes and sub-classes. The properties, relationships and predicates on each class were described using Protégé.

The ontology engineering tool “Protégé” was used to develop the timber ontology based on the model drawn in UML. Protégé is a free, open source ontology editor developed by Stanford Medical Informatics at the Stanford University School of Medicine. Protégé is based on Java and provides support for both Resource Description Framework (RDF) and Web Ontology Language (OWL) (Stanford Medical Informatics 2005). Protégé develops the ontology using a hierarchical structure shown in Figure 2.

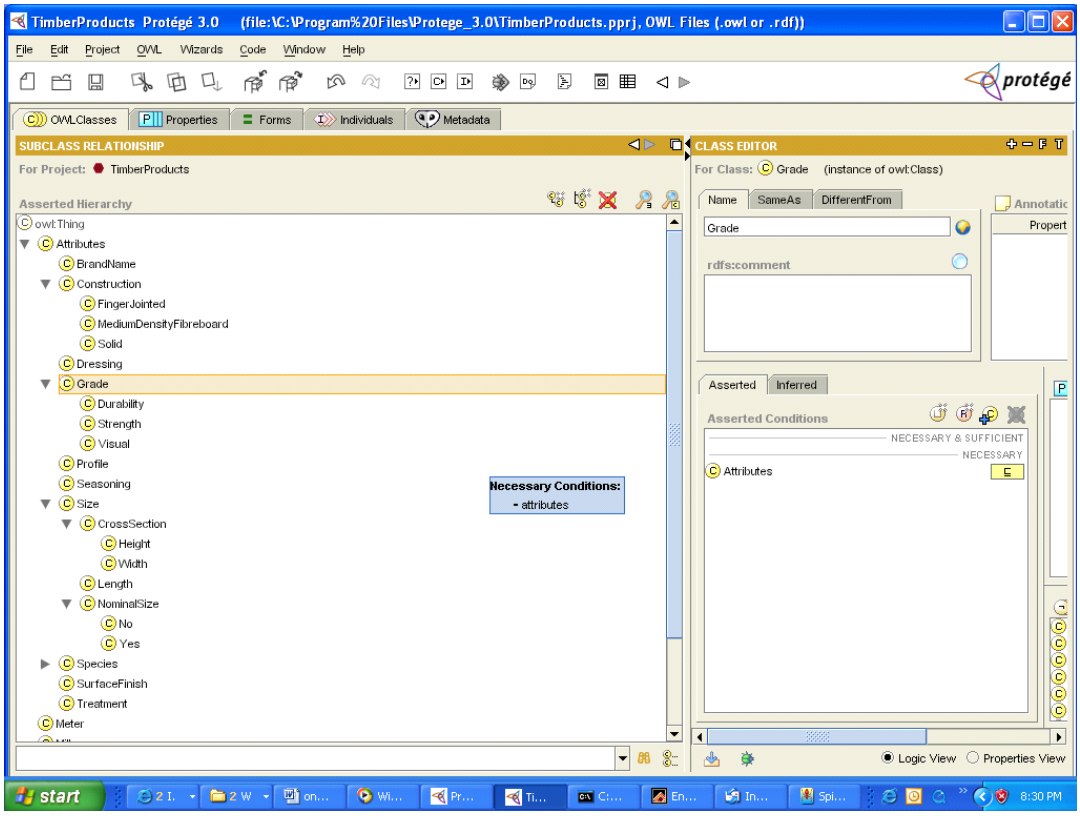

Figure 2. OWL classes developed in Protégé

Figure 3 shows the result of checking for logical consistency in the ontology using a logical reasoning system Racer. Racer and other reasoners are tools that can find new facts from existing data using deductive reasoning. An inconsistent class is one that cannot possibly contain any individuals as members. The reasoner can automatically determine the classification hierarchy which is called an inferred hierarchy and is shown in Figure 3.

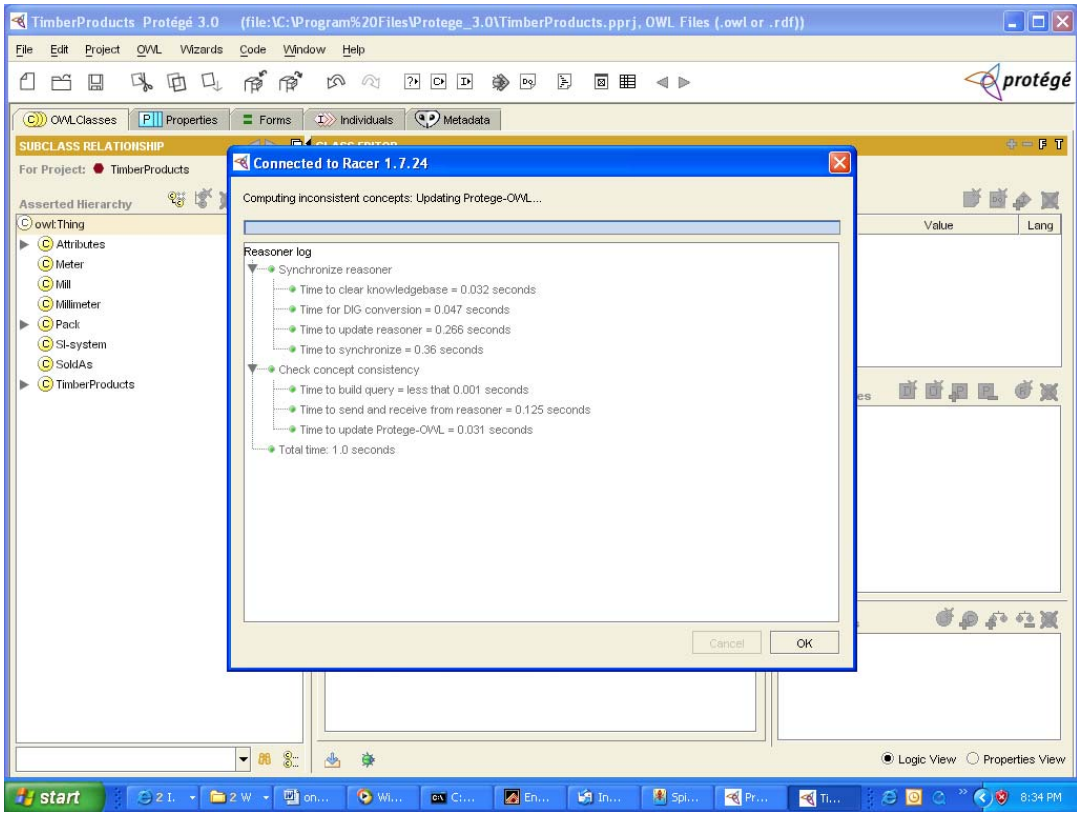

Figure 3. Consistency checking in Protégé using a reasoner

RDF was developed by the World Wide Web Consortium (W3C) as an XML based framework for describing and sharing metadata, designed to be applicable for sharing web metadata, and creating machine processable data on the Internet (Klyne & Carroll 2004). To ensure extendability RDF assumes an open world in which anyone can make statements about any

resource. RDF is designed to represent information in a minimally constraining, flexible way. RDF represents resources in a basic structure called a triple; these consist of a subject, predicate and object. The RDF triple is used to state that the relationship indicated by the predicate exists between a subject and object. RDF uses Uniform Resource Identifiers (URI) to identify resources. RDF Schema (RDFS) is an extension of RDF that contains supplementary predicates that allows the definition of more structure than RDF (Colomb, 2005). RDFS makes it possible to define a class, subclass and with an instance being defined using rdfs:Class, rdfs:subClassOF and rdf:type respectively shown in appendix D. RDF can be used in isolated applications, where individually designed formats might be more direct and easily understood, but RDFS' generality offer greater value from sharing (Colomb 2005; Klyne & Carroll 2004).

OWL is a specialisation of RDF also developed by the W3C designed to be compatible with putting ontologies on the web. OWL is used when the information is intended to be machine-processed and can be used to represent an ontology, (McGuinness & van Harmelen 2004) as the RDF structure is unable to support a reasoner (Colomb 2005). OWL extends RDFS by allowing the defining of complex relationships between different RDFS classes and contains the facility to more accurately place constraints on classes and properties. OWL has been designed to support reasoning with tools such as "Racer" within "Protégé" to support this and forms part of the activity surrounding the semantic web development. Like RDF, OWL

makes an open world assumption, so a class defined in one ontology can be extended in further ontologies (McGuinness & van Harmelen 2004).

In order that the proposed ontology meets Thomas Gruber's five concepts of ontological quality listed below and discussed in section 2.3.1, the following methods were used to improve the ontology quality. These methods provide a subjective means of improving quality, and further changes with future development will need to be made.

The principles:

- Clarity
- Coherence
- Extendability
- Minimal encoding bias
- Minimal ontological commitment (Gruber 1993b)

To support clarity, the meaning of the data entities should be able to be understood by means of a formal definition. Each data entity was looked at to determine if a formal definition should be given. Also to improve clarity, cardinality constraints are introduced between data entities, so each data entity must be examined to see if cardinality constraints should be introduced. Classes are scrutinised to see if they form *part of* the *whole* which is the superclass. The *part of property* is then assigned to the sub-class. To enhance clarity the sub-classes are examined to see if it is possible to "define" the sub-class, so that the *part of* property is objective rather than subjective. For coherence, the relationships between the data

entities must be examined, for circular or inconsistent rules. A reasoning tool such as Racer is also used to check for inconsistencies.

To enhance the extendability of the ontology, areas of future variability, are checked, and the same kind of process as database normalisation carried out. So that minimal encoding bias exists, the ontology must be examined for any possible areas of encoding bias. To increase extendability the ontology is inspected for areas of redundancy and where the construction of the ontology excludes a sector of the domain.

3.3 Ethical considerations

The questionnaire was important to establish a base line of what is happening in the Australian Timber Industry today and how that industry will react to the introduction of an alternative simplified means to transmit information within the supply chain.

A mail questionnaire was sent out to 2000 Australian timber industry organisations that are listed on the Forest and Forest Products Employment Skills Company Limited, industry database. This database, previously discussed in section 3.2.1 is, within the confines of privacy legislation, available for use by the industry and other members of the public. Forest and Forest Products Employment Skills Company Limited randomly chose a sample of 2000 addresses and forwarded the mailing address for that sample.

The questionnaire asked no personal information from the respondent apart from their job title and a brief description of their duties. The remainder of the requested data is general information about the organisation's business-to-business communication. A covering letter explained who funded the study and why the study was important. A contact telephone number for more information was provided on the covering letter.

There were minimal psychological or other risks to the participants, with no other personal information other than job title and a description of the participant's role in the organisation required. The other information requested was information about the organisation for whom the respondent worked. The imposition on the participants was minimal, with the participant not compelled or pressured to return the survey. The survey was designed to be able to be completed by most participants in ten to fifteen minutes and a reply paid envelope was supplied. The only reward offered for participating in the study was the opportunity of receiving a report summarising the results of the survey.

The study will benefit the participants by benefiting the Australian timber industry as a whole. The Australian timber industry is diverse in nature and includes the growing and management of trees through to the manufacture, merchandising and retailing of finished wood products. Due to its diverse nature there is a lack of information on the timber industry as a whole. This study provided information on the e-readiness or capacity of the Australian

timber industry to participate in a digital economy. This information will benefit the participants by exposing opportunities to improve use of information and communication technology (ICT) in the industry.

Informed consent was gained from the participants through the covering letter, with the receivers of the questionnaires being free to ignore the questionnaires or any questions if they wished.

Feed back to the participants will be provided in a report that will be freely available to the participants detailing the summarised findings from the questionnaire.

Anonymity of the participants was ensured through a variety of actions. The unique mailing code on the back page of the questionnaire was blocked out as soon as the respondent was crossed off the mailing list. No attempt was made to mark the identity of the respondent on the questionnaires by cross referencing with the mailing list. Only those respondents who wished to receive a report and those organisations who wished to participate in a further study were invited to fill out a contact sheet. In the event that the organisation wished to receive a report but not participate in any further study the contact sheet was detached from the questionnaire and stored in a separate file in a secure locked filing cabinet. If an organisation wished to be included in a further study then the questionnaire will be photocopied apart from the contact sheet so that the data does not have to be collected again. The photocopied questionnaire will be included with the other questionnaires with no contact information included. At no time were the names of

participants discussed with other participants in the study, no names appeared on any report or published document or will be passed to third parties. The principal researcher completed all tasks relating to the collating and data entry of the information contained in the questionnaires.

The computer stored data included no identification of the questionnaire respondent. The computer data files are password protected.

3.4 Conclusion

To first establish the level of e-readiness in the Australian timber and wood products industry a quantitative approach was used with the production of a questionnaire. The unit of analysis is the Australian timber and wood products industry, and contained embedded units of organisations participating in that industry.

The questionnaire was produced after a number of rounds of refinement. As the sample potentially contained a large number of SME's and was widely dispersed a mail survey was felt to be the best channel of distribution. The data was initially entered into a database to aid data entry accuracy before being imported into a statistical analysis program. That a questionnaire is an appropriate medium to test information flow within supply chains is demonstrated by researchers such as Rahman (2004) and Mullins, Duan and Hamblin (2001), while Fawcett and Magnan (2002) used questionnaires to test supply chain integration. Collaboration between suppliers and retailers was tested using questionnaires by Walker (1994).

4.0 Analysis of survey data

4.1 Introduction

The data gathered from the questionnaire and the construction of a foundation for a domain specific ontology is now discussed. First a discussion of the demographics of the sample is presented in section 4.2. The data concerning B2B communication is then examined in section 4.3, a brief overview in section 4.4, followed by the mechanics of ontology development and its application to the semantic web in section 4.5.

The questionnaire raw data from which the tables contained in section 4.2 and section 4.3 were extracted, is contained in appendix E, a compact disc.

4.2 Characteristics of the sample

A total of 242 respondents replied to the survey, which is a return rate of 12.1%. The respondents were asked to indicate the industry sector in which they operated. A total of 341 responses was received. This indicates that a number of the respondents operated across multiple sectors. This data is presented in Table 1.

Industry Sector	Frequency	Percent (%)
Forest growing and management	22	6.4
Harvesting and haulage	32	9.4
Sawmilling and processing	61	17.9
Timber products manufacturing	118	34.6
Wood panel/Board production and manufacturing	15	4.4
Pulp and paper manufacturing	5	1.5
Timber merchandising	88	25.8
Total	**341**	**100**

Table 1. Industry sector response

Table 2 shows the data relating to the size of the business and the number of respondents; 92.1% of organisations had fewer than 100 employees.

Business size (Number of employees)	Frequency	Percent (%)	Cumulative percent (%)
1-4	70	29.1	29
5-19	78	32.4	61.4
20-99	74	30.7	92.1
100 - 199	10	4.1	96.3
200 or more	9	3.7	100
Total	**241**	**100**	

Table 2. Number of respondents compared with size of business

This data shows that the industry has a larger proportion of organisations that employ over 100 people compared with that reported by the Australian Bureau of Statistics (2005b), in which they reported 99.0% of businesses employed less than 100 employees. There is no universal definition of Small to Medium Enterprises (SME), but it is generally accepted that organisations

that employ less than 200 employees are SME's. This means that most of the organisations in the Australian timber and wood products industry are SME's and can be described as second tier organisations.

Table 3 shows the distribution by state of multi-branch organisations, showing the count of organisations with that number of branches. The other sector is for those organisations that have off-shore branches. The table shows that the organisations located in New South Wales and Victoria have the highest concentration of multi-branch organisations.

The respondents were asked to choose between four definitions of business-to-business communication or note their own definition that reflected how the organisation defined its communication with other businesses. The result of this question is presented in Table 4. One respondent that wrote their own definition and defined business-to-business communication as "To receive and deliver information/ goods/ services using means appropriate to the project and our client's needs and expectations." No conclusion was able to be drawn from this data, as the respondents appear to have marked the first or second response even though the fourth response is a similar statement. The respondents appear to have marked these two responses to quickly answer a question leading to response bias and a lack of variance in the data (Zikmund 2003).

State	Number of branches	Count	Total Number of branch offices in a state
Tasmania	1	22	
	2	2	
	4	1	30
Victoria	1	66	
	2	8	
	3	6	
	4	3	
	5	1	
	9	1	
	16	1	142
New South Wales	1	69	
	2	12	
	3	5	
	4	1	
	10	2	
	12	1	134
Australian Capital Territory	1	7	7
Queensland	1	42	
	2	6	
	3	5	
	4	1	
	5	2	83
Western Australia	1	18	
	5	1	23
Northern Territory	1	1	1
South Australia	1	23	
	2	5	
	3	2	39
Other	2	1	2

Table 3. Number of branch offices in each state

Definition of business-to-business communication			
Definition	%	Count	Cumulative Percent (%)
To deliver information, products/services and payments over the telephone, communication networks or other means.	64.9	148	64.9
Any communication between two parties who are commercial in concept.	29.8	68	94.7
Access to information across geographic, organizational, and technology barriers.	2.2	5	96.9
Any business communication between two companies that uses digital technology	2.6	6	99.6
Other	0.4	1	100
Total		228	100

Table 4. Definition of business-to-business communication

Table 5 shows the data relating to the size of the business and the use of computers.

	Computer use					
	Yes		No		Total	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	62	26.0	7	2.9	69	28.9
5-19	74	31.1	4	1.7	78	32.8
20-99	73	30.7	1	0.4	74	31.1
100 - 199	9	3.8	0	0	9	3.8
200 or more	8	3.4	0	0	8	3.4
Total	226	95.0	12	5	238	100

Table 5. Computer use in the respondent's organisation

A relationship exists between the employment size of a business and the likelihood that the business will use information technology with a positive correlation coefficient of .92. One respondent or 0.4% in the 20-99

employees category did not use computers, with all respondents employing 100 or more employees using computers. In the 1-4 employee category there were 69 respondents, of these 7 (10.1%) did not use computers while in the 5-19 employee category 4 respondents (5%) did not use computers. These rates of computer use are approximately the same rate of computer use for manufacturing which had 88% computer use and wholesaling industries which had 91% computer use identified in the Australian Bureau of Statistics report (2005b). This means that computer use in the Australian timber and wood product industry is similar to that found in other Australian industry sectors.

Table 6 shows the data relating to the size of the business and having access to the Internet.

	Internet Access					
	Yes		**No**		**Total**	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	56	23.4	14	6.0	70	29.4
5-19	72	30.1	6	2.5	78	32.6
20-99	71	29.7	2	0.8	73	30.5
100 - 199	10	4.2	0	0	10	4.2
200 or more	8	3.3	0	0	8	3.3
Total	217	90.7	22	9.2	239	100

Table 6. Internet use in the respondent's organisation

Table 6 shows there is a relationship between the employment size of a business and the likelihood that the business will have Internet access with a

positive correlation coefficient of 0.90. Two respondents or 0.8% in the 20-99 employees category did not have Internet access, with all respondents employing 100 or more employees having Internet access. In the 1-4 employee category there were 70 respondents, of these 14 (20.0%) did not have Internet access. In the 5-19 employee category 6 respondents (7.7%) did not have Internet access. Both these rates of Internet access are slightly above the rate of Internet access for manufacturing industry which had a rate of 76% and wholesaling industries which had a rate of 86% as identified in the Australian Bureau of Statistics report (2005b). This means that the rate of Internet use in the Australian timber and wood product industry is slightly above the level in Australian industries such as construction and wholesale trade. Table 7 shows the data relating to the size of the business and the type of Internet access.

The main type of access is dial-up modem, although this reflects the large number of SME's in the sample as no organisations employing over 100 employees used dial-up modems for Internet access.

For those organisations employing 1-4 employees, 37 respondents (66.1%) were using dial-up modems, this may well reflect their remote or rural nature with a number of comments made on the survey that ADSL broadband was not yet available to them. Fourteen Respondents (25.0%) used ADSL broadband, 2 respondents (3.6%) used cable, with another 2 respondents (3.6%) using other means and 1 respondent (1.8%) using ISDN.

Internet Access														
	Dial-up		ADSL Broadband		Cable		ISDN		LAN, WAN or MAN		Other		Total	
Business size (Number of employees)	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
1-4	37	17.3	14	6.5	2	0.9	1	0.5	0	0	2	0.9	56	26.1
5-19	33	15.4	32	15.0	1	0.5	2	0.9	1	0.5	0	0	69	32.3
20-99	26	12.1	35	16.3	2	0.9	3	1.4	5	2.3	0	0	71	33.0
100 - 199	0	0	6	2.8	0	0	1	0.5	2	0.9	1	0.5	10	4.7
200 or more	0	0	1	0.5	1	0.5	2	0.9	4	1.9	0	0	8	3.8
Total	96	44.8	88	41.1	6	2.8	9	4.2	12	5.6	3	1.4	214	100

Table 7. Internet access type compared with size of business

For those organisations employing 5-19 employees, 33 respondents (47.8%) were using dial-up modems. 32 Respondents (46.4%) used ADSL broadband, 1 respondent (1.5%) used cable, 1 respondent (1.5%) used a Local Area Network (LAN), Wide Area Network (WAN) or Metropolitan Area Network (MAN), 2 respondents (2.9%) used ISDN with another 2 respondents (2.9%) using other means.

For organisations employing 20-99 employees, 26 respondents (36.6%) were using dial-up modems. 35 Respondents (49.3%) used ADSL broadband, 2 respondents (2.8%) used cable, 3 respondents (4.2%) used ISDN and 5 respondents (7.0%) used a LAN, WAN or MAN.

For organisations employing 100-199 employees no respondents were using dial-up modems. Six Respondents (60.0%) used ADSL broadband, no respondents used cable, 1 respondent (10.0%) used ISDN, 2 respondents (20.0%) used a LAN, WAN or MAN and one respondent (10.0%) used other means.

For organisations employing 200 or more employees no respondents were using dial-up modems. One Respondent (12.5%) used ADSL broadband, 1 Respondent (12.5%) used cable, 2 respondents (25.0%) used ISDN, 4 respondents (50.0%) used a LAN, WAN or MAN.

These results show the increase in importance of broadband Internet access as the employment size increases, until the organisation employs over 100 employees where the network technologies such as LAN, WAN's and MAN's

assume greater importance. The Australian Bureau of Statistics report (2005b) found that ADSL broadband access was the most popular type of Internet access with 67% of business identifying it as the main type. This means that the Australian timber and wood products industry at 46.4% is slower than Australian businesses as a whole at adopting ADSL broadband technology, which may be the result of the organisations being located in rural and remote areas.

Intrabranch communication

Table 8 shows an overview of how the respondent's organisations communicated with other branches of their organisation. 73 respondents belonged to organisations which maintained more than one branch office. The individual modes of communication are detailed in the following section.

Interbranch communication											
Mode of communication	Never		Rarely		Sometimes		Frequently		Constantly		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	%
Postal service	20	27.40	16	21.92	10	13.70	19	26.03	8	10.96	100
Fax	2	2.74	3	4.11	12	16.44	26	35.62	30	41.09	100
Telephone	0	0	0	0	4	5.48	22	30.14	47	64.38	100
Dial up modem	43	58.90	5	6.85	13	17.81	8	10.96	4	5.48	100
Broadband	43	59.72	2	2.78	4	5.55	4	5.55	19	26.39	100
Intranet	48	65.75	4	5.48	5	6.85	6	8.22	10	13.70	100
Satellite link	70	95.89	0	0	0	0	0	0	3	4.11	100
Leased line data service	61	83.56	2	2.74	0	0	0	0	10	13.70	100
Other	72	97.30	0	0	0	0	1	1.35	1	1.35	100

Table 8. Totals of interbranch communication

Postal service used for intrabranch communication

The bar graph in figure 4 shows how reliant the respondent organisations are on the postal service for interbranch communication.

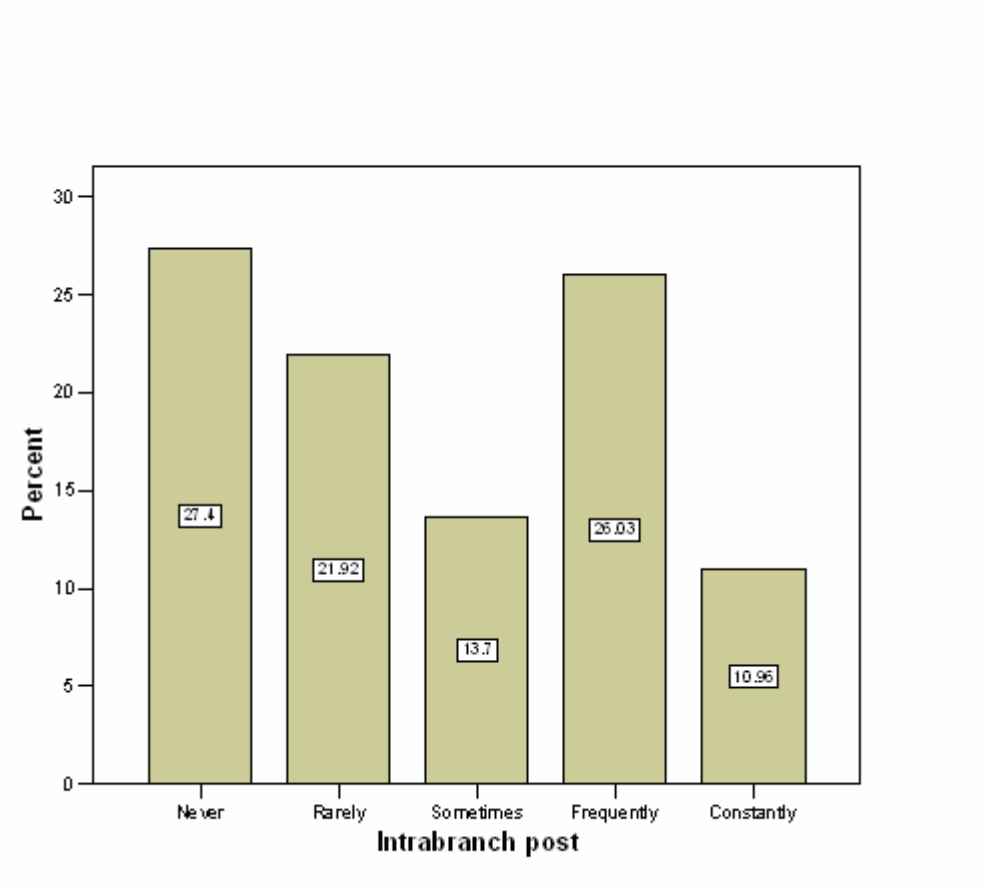

Figure 4. Use of the postal service for intrabranch communication

Of the 73 organisations who have more than one branch, 49.3% of organisations "rarely" or "never" use the postal service to communicate with other branches of their organisation. 50.7% of organisations use the postal service either "sometimes", "frequently" or "constantly". The remaining 11.0% of respondents' organisations used the postal service "constantly". The 20 respondents who never used the postal service were investigated to confirm their choice of both

intrabranch and business-to-business communication channels, this table is presented in Table 9.

		Interbranch				Business-to-business			
employ	No. of branches	rarely	sometimes	frequently	constantly	rarely	sometimes	frequently	constantly
1-4	1	Dial-up		Fax	Phone		Phone		In-person
1-4	3			Fax	Phone Broadband Intranet			Fax	Post Phone Email
5-19	2				Phone Fax				Post Fax Phone Email
5-19	2				Fax Phone				Post Fax Phone Email
5-19	2				Fax Phone	email	Post		Fax Phone
5-19	1		Fax	Phone				Email	Post Fax Phone
20-99	2			Fax Dial-up	Phone		Post	Fax	Phone
20-99	2		Dial-up	Phone			email		Phone Fax
20-99	1				Phone	email	Post	Fax	Phone
20-99	1		Fax	Phone	Intranet		Post email	Fax	Phone
20-99	2	Dial-up	Fax Phone				Post email	Fax	Phone
20-99	4		Fax	Phone	Trunk radio system				Post Fax Phone Email
20-99	3				Phone Fax			Post email	Fax Phone
20-99	3			Fax	Phone			email	Post Fax Phone
20-99	3		Broadband	Fax	Phone Intranet Leased line				Post Fax Phone Email
20-99	4			Fax	Phone Broadband		Fax	email	Phone
20-99	2		Phone Broadband Intranet		Fax Leased line			Fax Phone Email	
100-199	8			Fax Phone Broadband				Fax Phone Email EDI	
200 +	5	Fax	Phone		Broadband Intranet		Post Fax email		Phone
200 +	8		Fax Phone						Post Fax Phone Email

Table 9. The communication channels chosen by organisations that do not use the postal service intrabranch.

This table shows that it is not only the organisations that employ over 100 employees who have abandoned the postal service as a communication channel intrabranch, but also includes SME's. However it appears that in this sample the organisations that employ over 20 are more likely to replace the postal service with an electronic form of communication other than fax, for instance broadband, intranet or a leased line. In this group of respondents email is playing a significant role in business-to-business communication.

Facsimile used for intrabranch communication

The importance of the facsimile machine for intrabranch communication is illustrated in the bar graph in Figure 5 and the graph shows a median of "frequently" and standard deviation of 0.997.

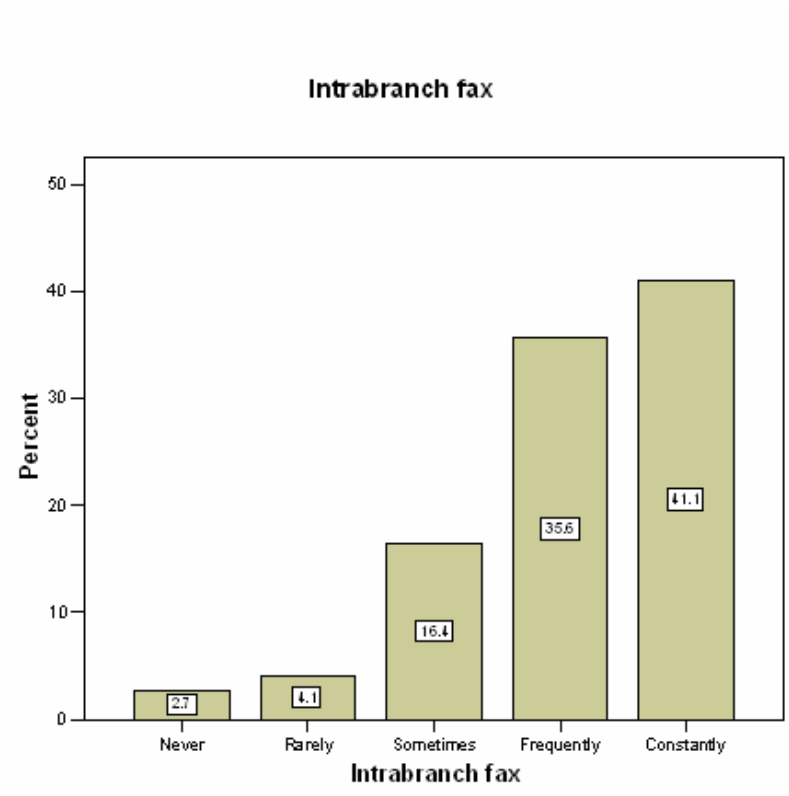

Figure 5. Use of a fax machine in intrabranch communication

The importance of the facsimile machine for intrabranch communication is illustrated in the graph. There are 6.8% of respondents' organisations using the facsimile "never" or "rarely", with the remainder of 93.2% using the facsimile a minium of "sometimes". 41.1% use the facsimile constantly; these results show that for these respondents the facsimile is one of the most important forms of intrabranch communication.

Phone used for intrabranch communication

The bar graph in Figure 6 shows the importance of the telephone as a means of intrabranch communication.

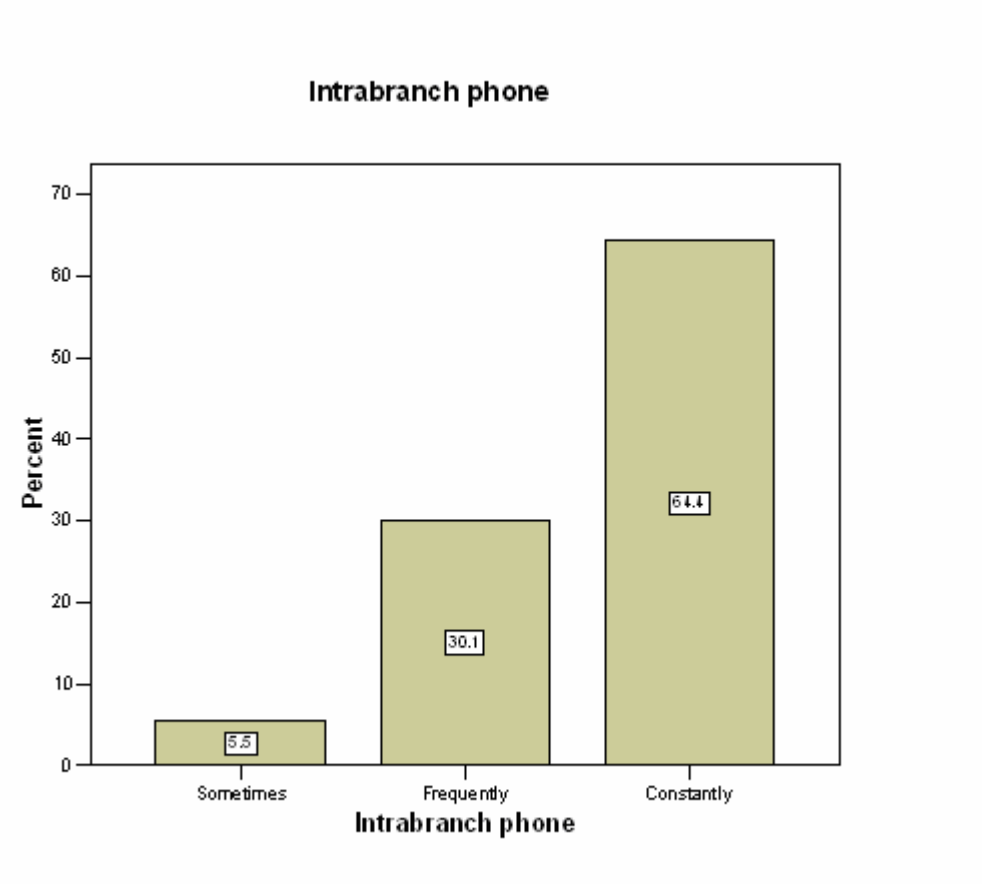

Figure 6. Use of the telephone for intrabranch communication

The graph shows that the telephone is used by all respondents for intrabranch communication. The use of the telephone is a minimum of "sometimes", with 94.5% using the telephone "frequently" or "constantly", with a median of "frequently" and standard deviation of 0.597. These figures show that in terms of frequency of use the telephone is the most important form of communication between organisational branches.

Dial up access used for intrabranch communication

The use of a dial up Internet connection is demonstrated in Figure 7.

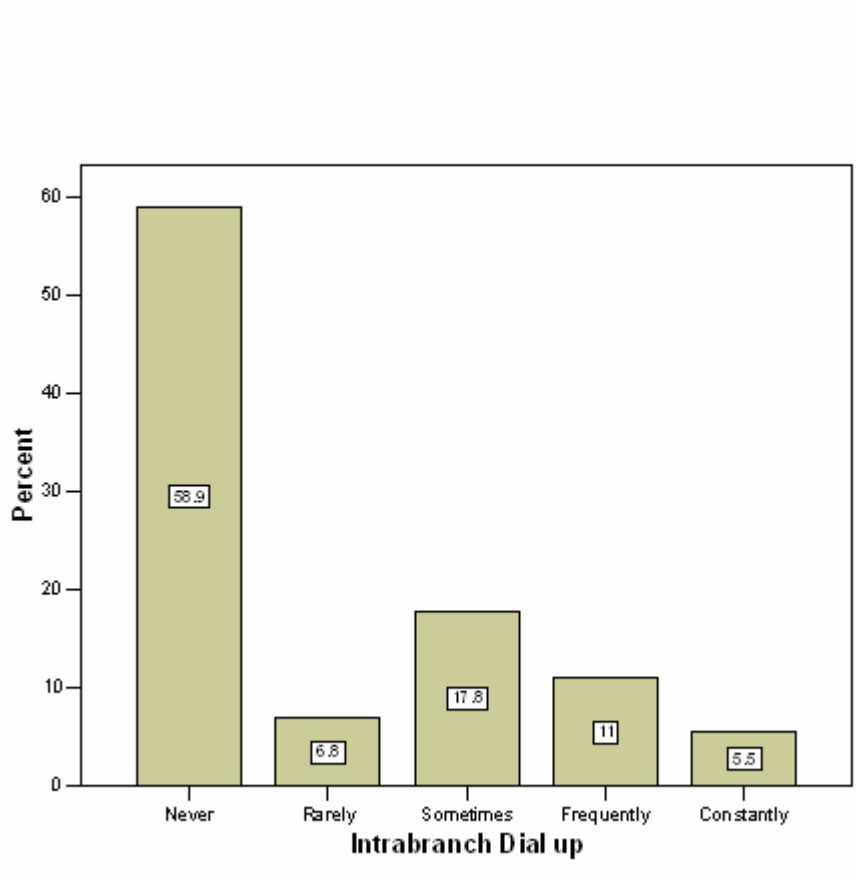

Figure 7. Use of dial-up Internet access for intrabranch communication

Dial-up access to the Internet does not play a big role in interbranch organisational communication demonstrated by the 58.9% of respondents who “never” use dial-up access to the Internet. This group either does not have this technology or uses another Internet technology such as broadband Internet access for interbranch communication. The median for these responses is “never” with a standard deviation of 1.312. A further 6.9% used dial-up access “rarely” and 17.8% “sometimes”. Respondents, who used dial up Internet access as a communication channel, either “frequently” or “constantly”, made up 16.4% of the respondents who had more than one branch.

Broadband access used for intrabranch communication

The frequency of use for using a broadband connection as a communication channel for intrabranch communication is shown in the bar graph in Figure 8. Broadband access to the Internet, like dial up access, also does not play a big role in interbranch organisational communication demonstrated by the 59.8% of respondents who “never” use broadband access to the Internet. This group either does not have this technology or uses another Internet technology such as an intranet for interbranch communication. The median for these responses is “never” with a standard deviation of 1.779, the number of respondents who use broadband “constantly” compared to dial-up (*S* = 1.312*)* is demonstrated by the bigger standard deviation. A further 2.8% used broadband access “rarely” and 5.5% “sometimes”. 31.9% of respondents accessed the Internet through broadband access using this channel for intrabranch communication either “frequently” or “constantly”.

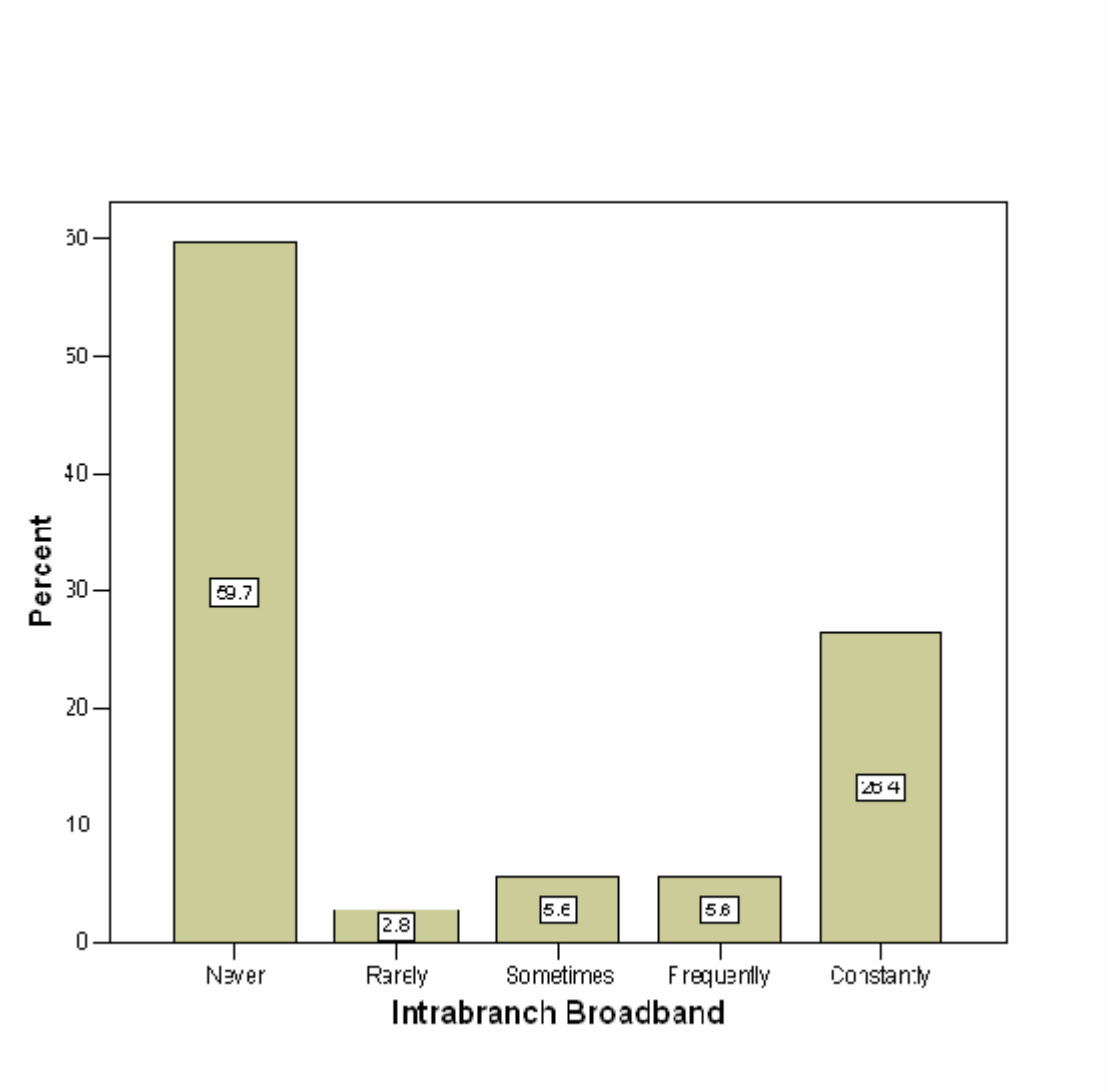

Figure 8. Use of a broadband Internet access in intrabranch communication

Intranet used for intrabranch communication

How frequently an intranet is used for intrabranch communication is demonstrated in the bar graph in Figure 9.

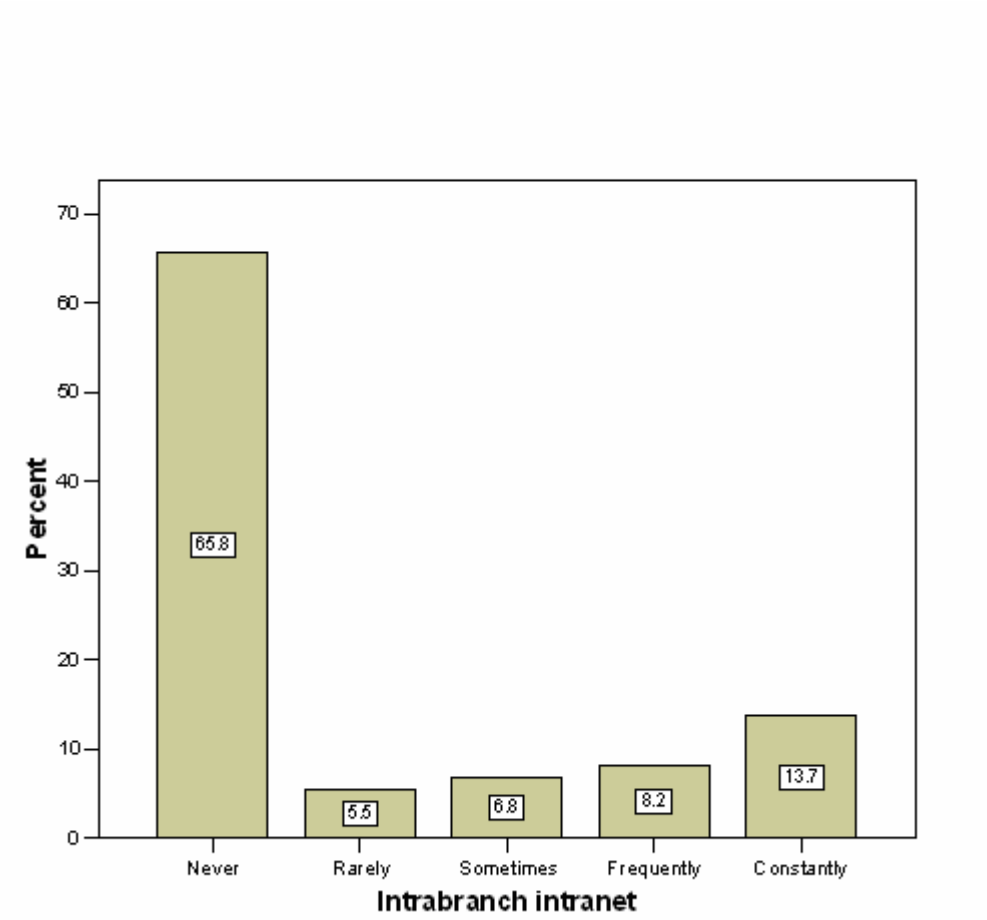

Figure 9. Use of an intranet in intrabranch communication

An intranet does not play a big overall role in interbranch organisational communication demonstrated by the 65.6% of respondents who “never” use an intranet for communication. This group may not have this technology or uses another Internet technology such as a broadband for interbranch communication. The median for these responses is “never” with a standard deviation of 1.523. An intranet was used “rarely” by 5.5% and 6.8% “sometimes”. 21.9% respondents used an intranet either “frequently” or “constantly”. The respondents who used an intranet either “constantly” or “frequently” were further investigated in terms of their employment size, the results of this investigation are shown in Table 10.

Use of an intranet for intrabranch communication		
Employment Size	Frequently	Constantly
0 - 4	1	1
5 - 19	1	0
20 - 99	4	5
100 - 199	0	2
200 +	0	2

Table 10. Use of an intranet for intrabranch communication compared with employment size

This table shows that of the 18 organisations that have more than one branch and employ over 100 people, four organisations or 22.2% use an intranet either “frequently” or “constantly” for intrabranch communication. For the organisations that employ between five and nineteen people, nine organisations of the 35 in this category or 25.7% use an intranet “frequently” or “constantly”.

Satellite used for intrabranch communication

The use of a satellite link for intrabranch communication is shown in the bar graph in Figure 10. This graph shows that most respondents do not use or maintain a satellite link, with 95.9% of the respondents never using this technology. However the 4.1% of respondents who use a satellite link for Internet access use the technology constantly. The median for these responses is “never” with a standard deviation of 0.800. Three respondents, who use a satellite link constantly for intrabranch communication, fall into the 1 to 4, 20 to 99 and 200 plus employees. The respondent from the organisation that employed 1 to 4 people specified that they used a satellite

link for their means of Internet connection, so this result can not be considered an error.

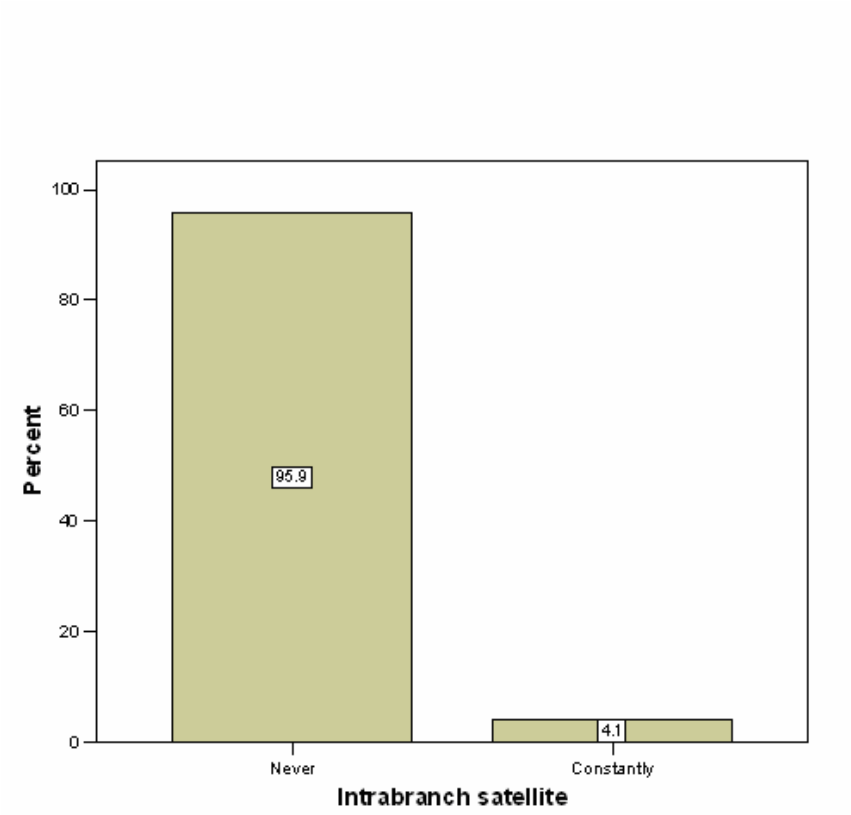

Figure 10. Use of a satellite link for intrabranch communication

Leased line data service used for intrabranch communication

Figure 11 shows that, correspondingly with a satellite link, most respondents neither use nor have a leased line data service, with 83.6% of the respondents never using this technology. A further 2.7% of respondents indicated that their organisations used this technology rarely; however this technology requires a heavy investment of resources and so is unlikely to be used rarely; therefore these responses may be from respondents who selected this option incorrectly. The 13.7% of respondents who used a leased line data service for Internet access used the technology constantly.

Of the ten organisations that used the technology constantly, four employed 20 to 99 employees, two employed 100 to 199 employees and the remaining four organisations were over 200 employees. The median for all 73 responses is “never”.

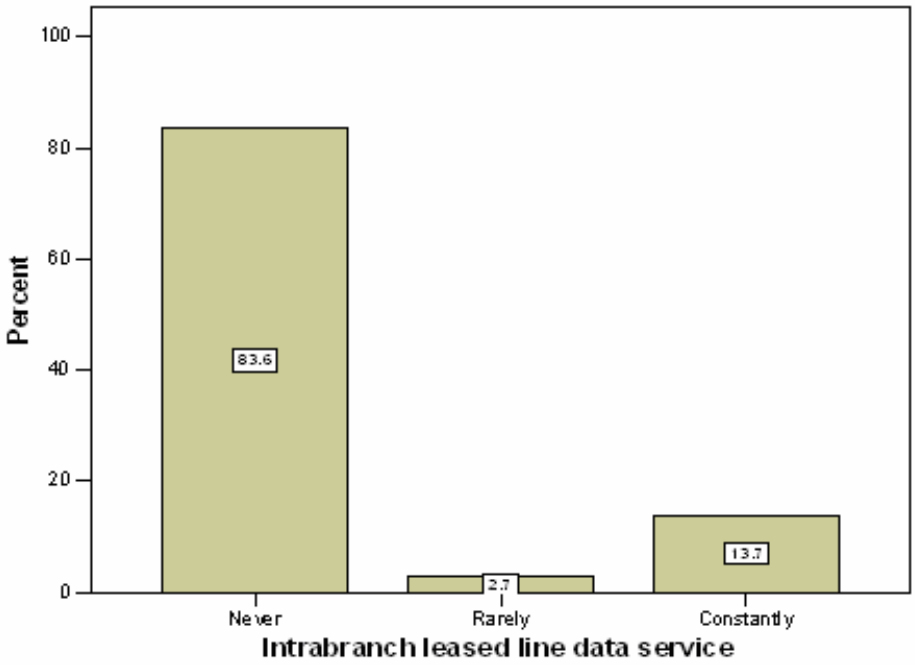

Figure 11. Use of a leased line for intrabranch communication

Other technologies used for intrabranch communication

Two respondents used another form of intrabranch communication, radio. One respondent’s organisation is using a UHF radio system frequently, the other respondent’s organisation is using a trunk radio system constantly.

Conclusion for Interbranch communication

These figures show that the non-Internet technologies of the postal service, fax and telephone are used more frequently than Internet technologies for interbranch communication. However the data shows that where a higher technology than a dial-up modem exists in the organisation's communication strategy then this technology is used extensively for intrabranch communication. This is demonstrated well with the figures for a leased line data service where those people who use the service do so constantly.

4.3 Business-to-business communication

Table 11 shows the frequency of the respondents' answers to the questions on business-to-business communication. These modes of communication will be looked at separately in the following section.

Business-to-business communication											
Mode of communication	Never		Rarely		Sometimes		Frequently		Constantly		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	%
Postal service	17	7.02	12	4.96	34	14.05	91	37.60	88	36.36	100
Fax	4	1.65	6	2.48	20	8.26	87	35.95	125	51.65	100
Telephone	0	0	1	0.41	3	1.24	57	23.55	181	74.79	100
email	37	15.29	37	15.29	61	25.21	56	23.14	51	21.07	100
Extranet	226	94.17	7	2.92	7	2.92	0	0	0	0	100
EDI	203	83.88	11	4.55	15	6.19	10	4.13	3	1.24	100
Other	239	98.76	0	0	0	0	2	0.83	1	0.41	100

Table 11. Total values for all modes of business-to-business communication

Business-to-business postal communication

The postal service still plays an important role in business-to-business communication as demonstrated in the bar graph in Figure 12.

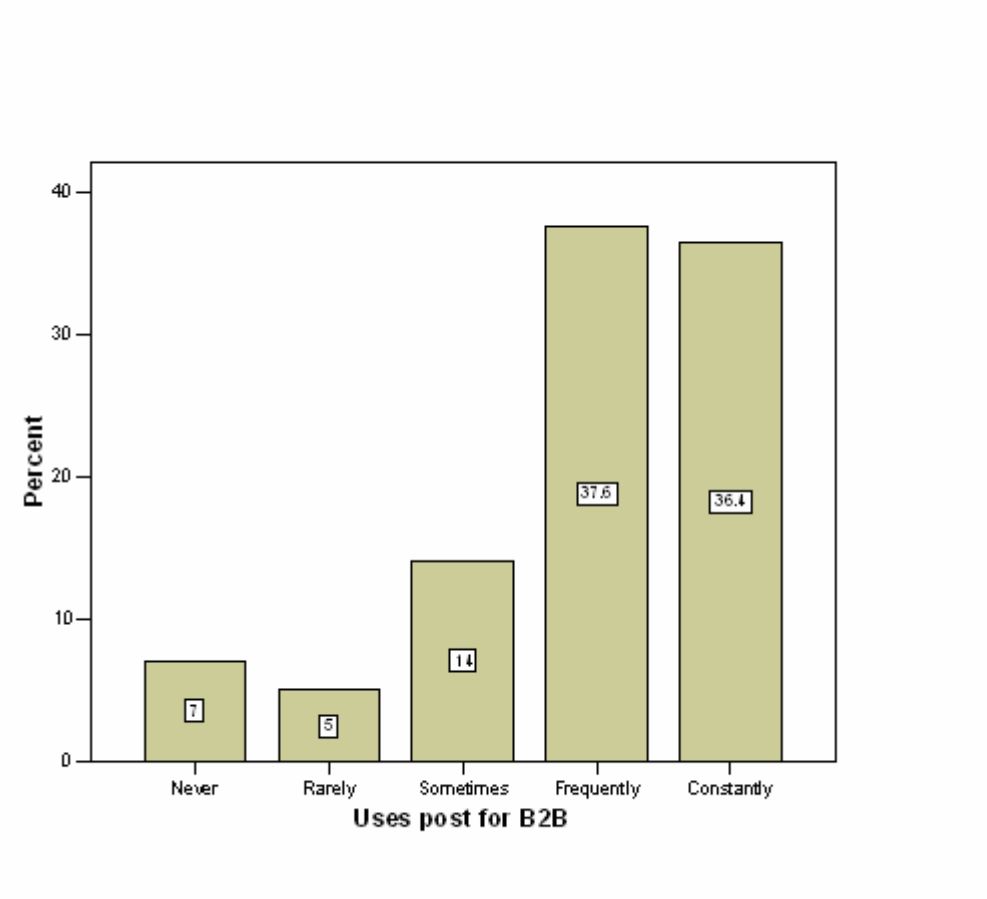

Figure 12. Use of the postal service for business-to-business communication

The postal service is never used by 7.0% with a further 5.0% rarely using the postal service. The remaining 88.0% use the postal service at least sometimes for business-to-business communication, 36.4% constantly and 37.6% frequently. The data had a median of “sometimes” and a standard deviation 1.154.

Business-to-business facsimile communication

The facsimile has an essential place in current business-to-business communication practices; this is shown in the bar graph in Figure 13.

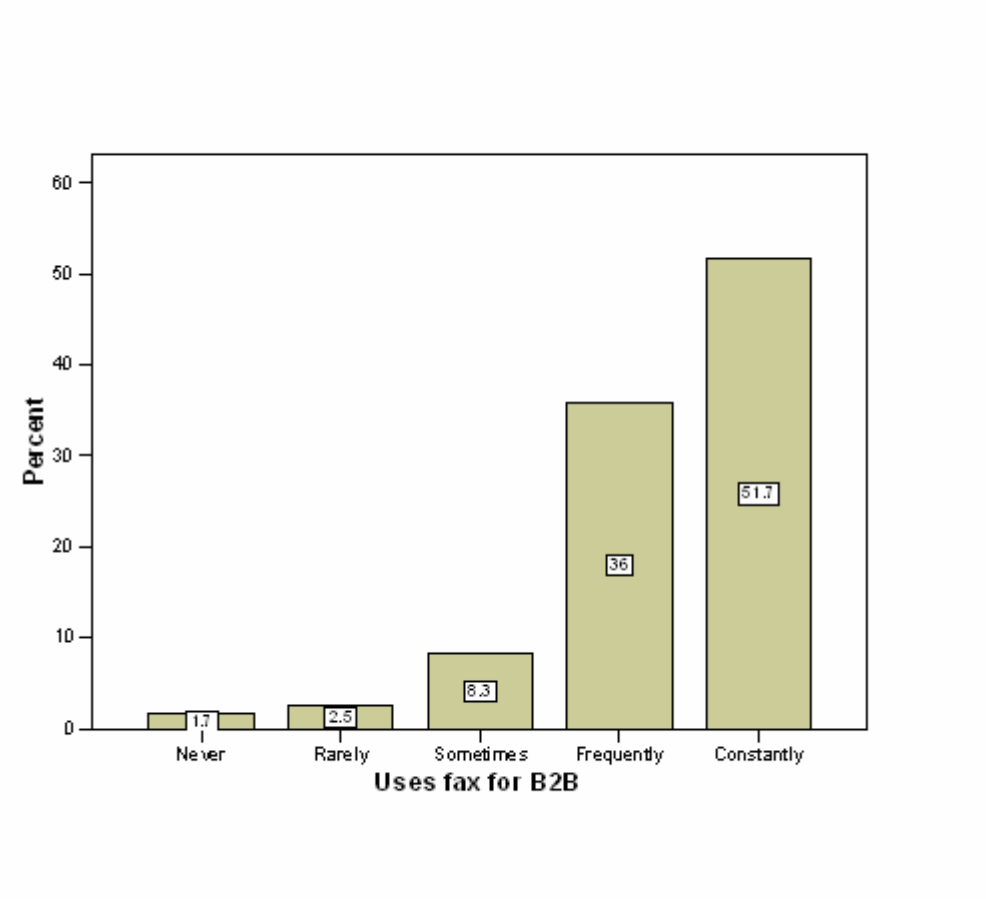

Figure 13. Use of a facsimile machine for business-to-business communication

The facsimile is never used by 1.6% with a further 2.5% rarely using the facsimile. The remaining 95.9% use a facsimile at least sometimes for business-to-business communication, 51.7% constantly and 36.0% frequently. The responses have a median of “frequently” and a standard deviation 0.859.

Business-to-business telephone communication

All respondents use the telephone for business-to-business communication as shown in Figure 14.

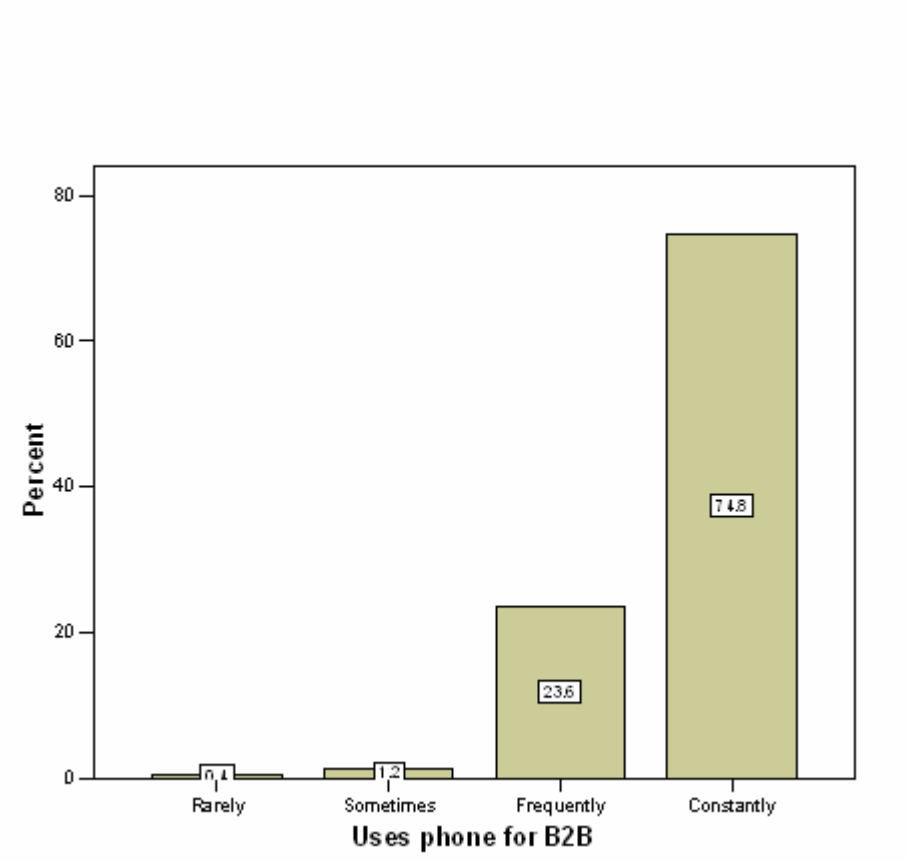

Figure 14. Use of the telephone for business-to-business communication

One respondent or 0.4% used the telephone rarely, on examining their data it was found that this organisation employed 1 to 4 employees and used the postal service frequently and a facsimile sometimes for business-to-business communication. The remaining 95.6% used the telephone at least sometimes for communicating with other businesses, 74.8% using the telephone constantly. The median is “constantly” and the standard deviation

is 0.499. This result shows that the telephone in this sample is the main communication channel between businesses.

Business-to-business email communication

Email is an established mode of business-to-business communication as shown in Figure 15.

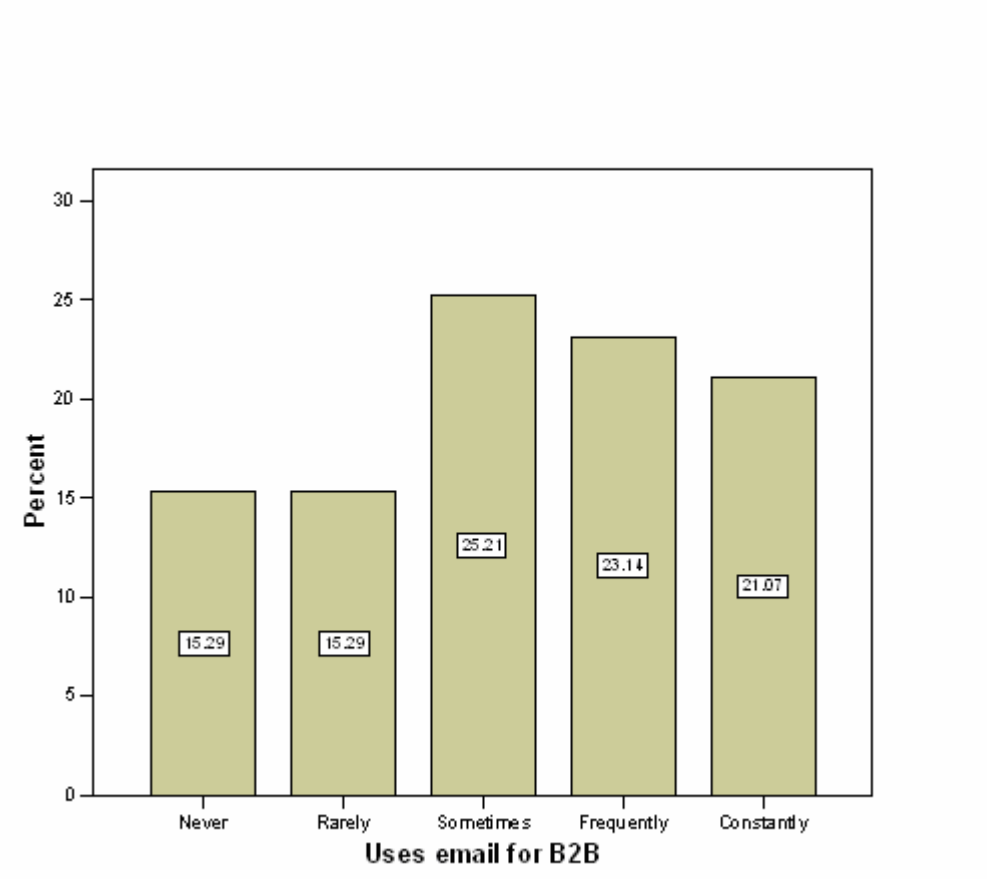

Figure 15. Use of email for business-to-business communication

The 15.3% of respondents who never used email also includes the 9.3% of respondents who do not have Internet access, a further 15.3% of respondents use email rarely as a communication mode. The remaining

69.4% used email at least sometimes, with 25.2% using email sometimes, 23.1% frequently and 21.1% constantly. The median is “sometimes” and the standard deviation is 1.345.

Business-to-business extranet communication

An extranet is not used extensively by the respondents for business-to-business communication as shown in Figure 16.

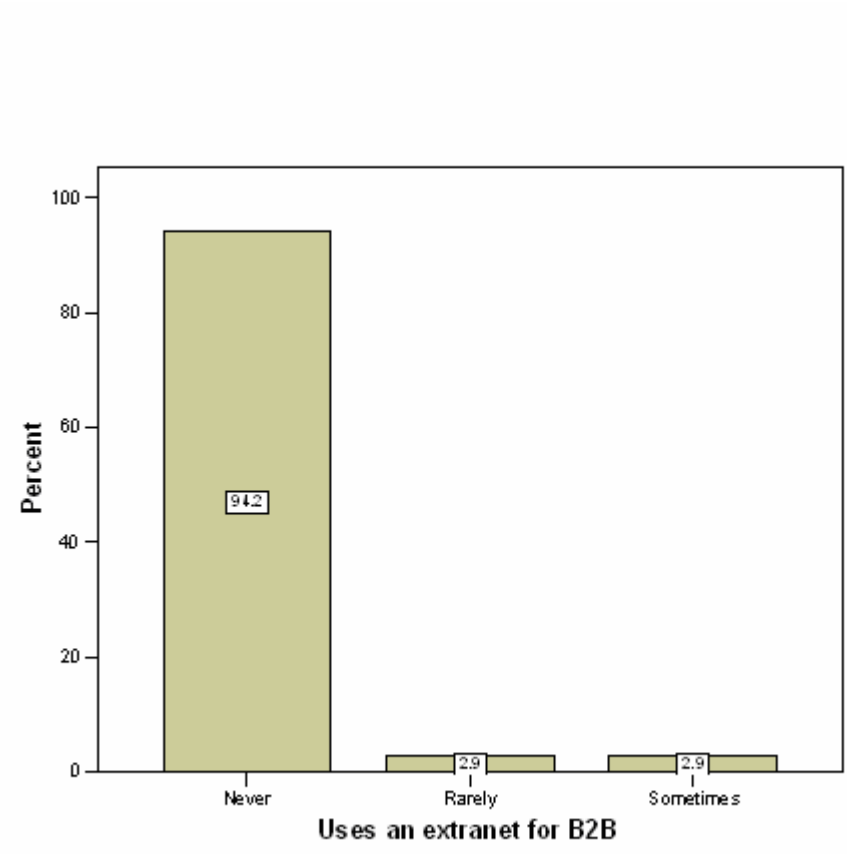

Figure 16. Use of an extranet for business-to-business communication

The 94.2% of respondents who never used an extranet also includes those respondents who do not have Internet access, a further 2.9% of respondents

used an extranet rarely and 2.9% sometimes as a communication mode. The median is “never” and the standard deviation is 0.372.

Business-to-business electronic data interchange communication

An EDI system is not used widely by the respondents for business-to-business communication as shown in Figure 17.

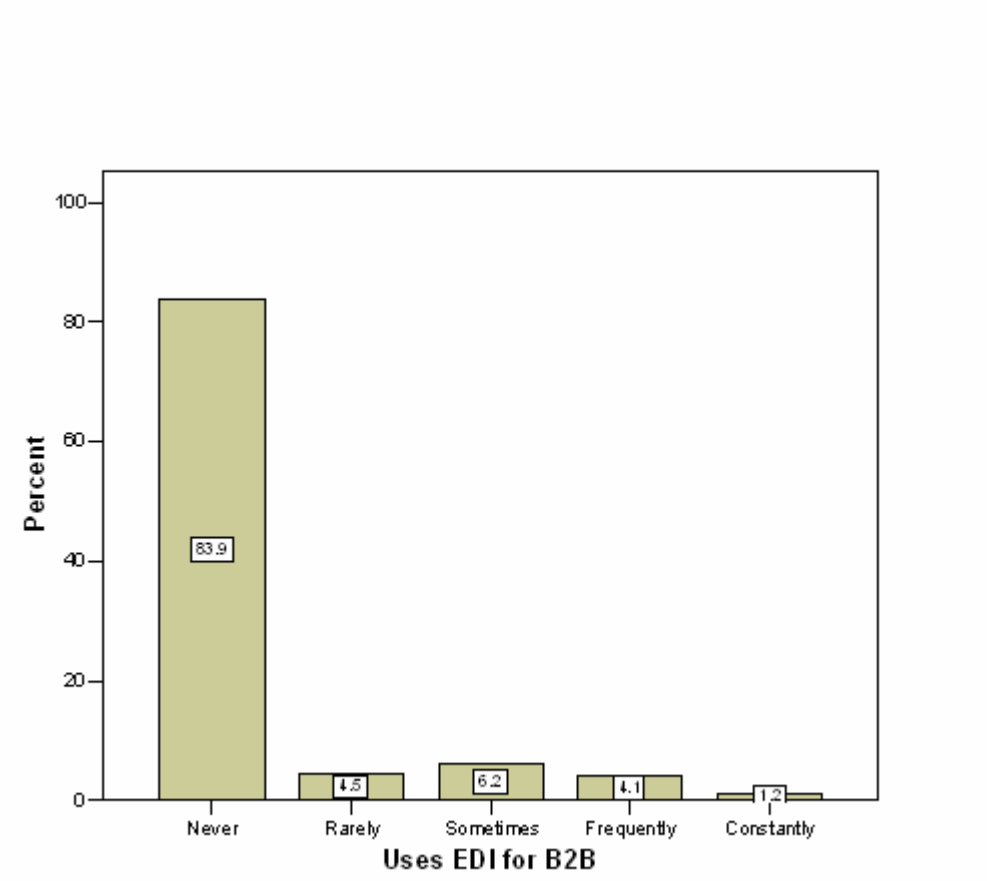

Figure 17. Use of EDI for business-to-business communication

83.9% of respondents never use EDI, with a further 4.5% of respondents using an EDI system rarely and 6.2% sometimes as a communication mode.

An EDI system is used frequently by 4.1% and constantly by 1.2%. The median is “never” and the standard deviation is 0.866.

Other forms of business-to-business communication

Two respondents indicated that they used in-person communication frequently for business-to-business communication, with a further 12 respondents or 4.97% making a note that they considered in-person to be an important form of business-to-business communication. One respondent indicated that they used a mobile telephone constantly. This data is shown in Figure 18.

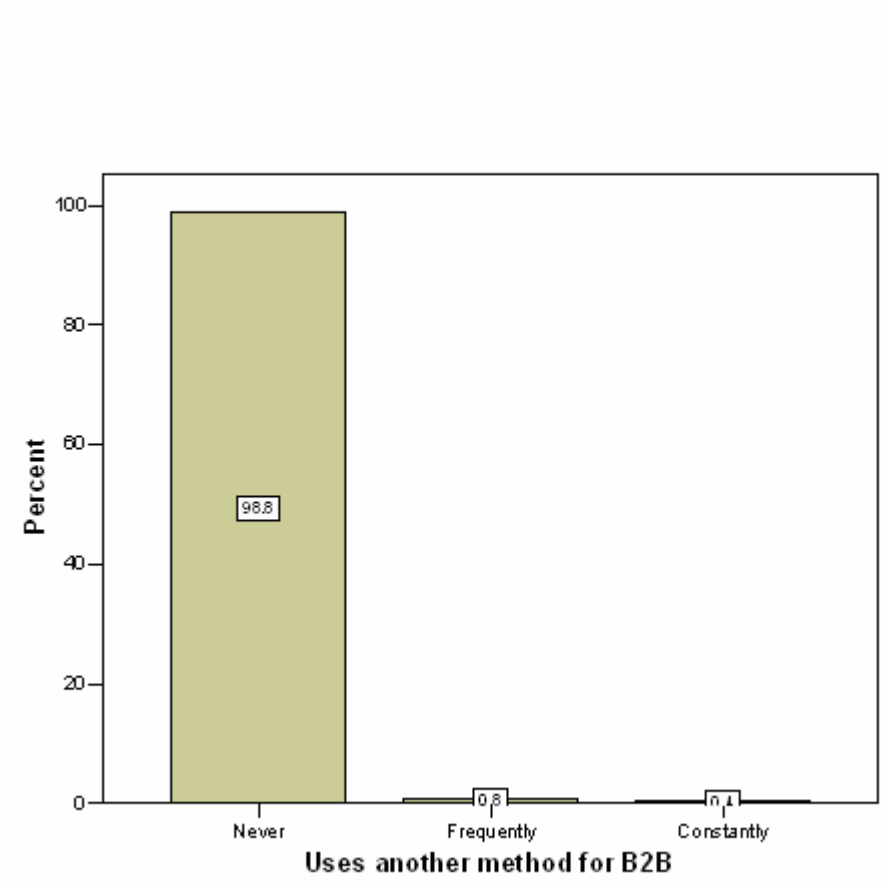

Figure 18. Use of other technologies for business-to-business communication

Conclusion for B2B communication

Both for intrabranch and business-to-business communication, the established communication modes of the postal service, telephone or facsimile are the most frequently used communication's modes. The intrabranch communication table demonstrates that where a constant data link is maintained, for instance with a satellite link or leased line data service, then that link is used constantly.

In an examination of the purchase process study by Cano, Boles and Bean (2005) they concluded that the telephone was used as second only to in-person meeting as the communication channel with the ability to express the richness of a message. In this case richness means the communication channels ability to convey the message unambiguously, Daft and Lengel (1986, p. 560) defining information richness as "*the ability of the information to change understanding within a time interval*".

During the purchase process, Cano, Boles and Bean (2005) suggest that customers still desire a personal relationship with the sales staff. This may explain the reliance on the telephone in the sample, as it is used as a replacement for face-to-face meetings. They go on to say that while an organisation is in the process of adopting email, they use email to substitute for written communication.

The widespread use of established communication modes may be a product of the high number of SME's in the sample, large organisations may have set products listings, so that once a relationship has been established using information rich communication channels such as in-person meetings, repeat orders can be sent using written communication, such as email with no ambiguity. That in the Australian forestry and wood product industry in-person meetings are very important is demonstrated in the next section, where respondents commented that in-person communication was most important.

Comments on Issues important in business-to-business communication.

Open ended questions were inserted after question 16 on IT governance and respondents were asked to comment on "other issues that your organisation believes are important in business-to-business communication" both now and in the future. Sixty three comments were made by respondents for this question. A content analysis was carried out on the comments made, and six main themes emerged as detailed below.

1. Dissatisfaction with current communication service.
2. Broadband necessary but not available in their area.
3. These questions are not applicable or not a priority.
4. In-person communication was more important.
5. Difficulty with keeping up with technology or technology costs.
6. Business-to-business relationships.

Dissatisfaction with current communication service.

Seven comments were made on dissatisfaction with the current level of service being offered by the telecommunications' organisations. Two organisations repeated their comment about their lack of satisfaction with the current communication service being an issue for business-to-business communication both now and in the future:

- "lack of mobile phone coverage in our area prevents mobile plant and equipment from communication downloads"
- "Failure of landlines, mobile service by providers"
- "Australia post, Telstra"
- "The cost of mobile phone use for Internet and normal phone users far to high"
- "Cost of communication"
- "Sawmill office is located in a remote location and phone line services etc have always been below par with lack of desired services available, frequent lightning strikes affecting phone lines"
- "Cheaper satellite phone call rates"

These comments came from regional South Australia, New South Wales and Victoria. These comments show that a regional location is a barrier to adoption of better connectivity with desired level of services not available in the respondent's area. The cost of the communication service is also shown to be a barrier in these comments.

Broadband necessary but not available in area

There were three comments made about the lack of broadband service in the respondent's area, two from regional Victoria and one from regional New South Wales. All these respondents saw this as an issue now and not in the future so they have an expectation a broadband service will be offered to them in the future.

- "We have a complete lack of support from Telstra to improve our current service. Telstra does not provide broadband access"
- "Broadband is highly desirable for two office locations but is not available at either location at this point in time. Need to be able to keep our fax lines open whilst researching, banking and emailing online. Currently looking to have ADSL set up"
- "ADSL broadband is not available to us at this stage"

The first quotation is from an organisation employing 1-4 employees, the second employs 5-19 employees and the third quotation is from an organisation that employs 20-99 employees. These comments demonstrate that geographic isolation coupled with a lack of technology infrastructure is a barrier to the adoption of broadband and the potential competitive advantages that accompany higher levels of connectivity for a business organisation.

These questions not applicable or the issue is not a priority.

Five comments were made that this question was not applicable to their organisation or that business-to-business communication was not an issue for them now.

- “I don't believe that communications will be an issue for about 10 years”
- “No issues”
- “Not a priority now”
- “None of this really applies to us”
- “Not applicable, maybe in the future we will consider a computer”

All these comments came from organisations that employ less than 20 employees and are located near either the capital city of their state or a large regional centre. This demonstrates that while geographic isolation is not acting as a barrier, these organisations have not yet reached an employment size where business-to-business communication is an issue.

In-person communication is more important.

Ten comments were made on the importance of maintaining in-person communication, three respondents feeling strongly enough about this issue to say that this is an issue in business-to-business communication both now and in the future. Five comments were made identifying this as an issue now

with five more comments identifying this as an issue in the future:

- “Company representative manner”
- “In-person”
- “Less personal contact”
- “Personal contact with business partners remains a priority, higher than that of other impersonal communications”
- “The need for face to face contact to establish better feelings and relationships”
- “Maintaining the current level of personal contact with large businesses may become more difficult”
- “More in-person”
- “Prefer face to face communication”
- “Security, cost, loss of face to face or individual customer service”
- “Direct face to face meetings are still very important”

These comments all came from organisations employing less than 100 employees indicating that this is an issue for small organisations, with the need for face to face contact to establish a trading partnership disappearing when the organisation gains sufficient size and infrastructure to employ 100 people.

Difficulty with keeping up with technology or technology costs.

Six comments were made on the difficulty with keeping up with the pace of technology change or the cost of technology, three organisations recognised this as an issue in their present business-to-business communication, while a further three organisations saw this as an future issue.

- “Being able to afford to keep pace with changing technology”
- “Our main concern is that as a very small business we may be left behind if we can't afford to keep updating technology”
- “Cost of implementation”
- “Assessing which will be the best ongoing systems and when to upgrade to them”
- “Keeping up with the pace. Innovations etc, upgrading computer equipment, knowledge and expenses”
- “Cost of technology”

This was an issue which spanned across the range of employment size, with a comment coming from each employment size category, two comments from the 5-19 employee category.

Business-to business relationship theme

There were three comments that indicated the organisation viewed the development of strong business-to-business technology relationships as being important now:

- “Education of technology and establishing B2B relationships that are useful and compatible”
- “Having multi-methods of communication so that you can reach all sectors, customers, suppliers, trading partners who are at different levels of development and interest”
- “EDI between supplier and customer”

The top two quotations are from organisations employing 20-99 employees, while the last quotation concerning EDI is from an organisation employing 200 or more employees.

The following three comments saw the development of business-to-business technology relationships as an important “future” issue:

- “One system for all equals understanding “
- “Customers update systems to allow better communication”
- “e-commerce standards adoption across all extended supply chain partners”

The first quotation is from an organisation employing 20-99 employees while the last two quotations are from organisations employing over 200 employees.

These comments reinforce that the size of an organisation acts as a barrier to the diffusion of an innovation. The organisations employing 20-99 employees are concerned with the technical details of business-to-business interoperability while the organisations employing over 200 employees are concerned with putting in place sophisticated techniques for business-to-business communication such as EDI. Fillis, Johannson and Wagner (2004) postulate that one of barriers to the integration of the Internet into an organisation is a competency/ skills gap in information systems. The time to develop appropriate skills and investment in training of information skills may be an artefact of employment size.

Information technology planning and strategies

Table 12 shows the data relating to the size of the business and whether they maintain an information systems strategic plan. The data shows that 202 respondents (85.9%) do not maintain a strategic plan of how they will support their business objectives with information systems. For organisations employing 1-4 employees, 4 respondents (5.9%) maintain an information systems strategic plan. In organisations employing 5-19 employees, 7 respondents (9.2%) maintain an information systems strategic plan. For organisations employing 20-99 employees, 11 respondents (15.3%) maintain

an information systems strategic plan. In organisations employing 100-199 employees, 4 respondents (40.0%) maintain an information systems strategic plan. In organisations employing over 200 employees, 7 respondents (77.7%) maintain an information systems strategic plan. In Wilson and Dean's (2000) study of e-business adoption in SME's, 20% of their respondents indicated that they maintained a formal e-business strategic plan which is in general agreement with this study.

	The organisation maintains an information systems strategic plan					
	Yes		**No**		**Total**	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	4	1.7	64	27.2	68	28.9
5-19	7	3.0	69	29.4	76	32.4
20-99	11	4.7	61	26.0	72	30.7
100 - 199	4	1.7	6	2.5	10	4.2
200 or more	7	3.0	2	0.8	9	3.8
Total	33	14.1	202	85.9	235	100

Table 12. The organisation maintains an information system strategic plan compared with size of business

The importance of maintaining an information strategic plan increases with employment size, but the knowledge that 22.3% of tier 1 organisations do not maintain a plan despite an obvious large investment in information systems bears out Scupola's (2002) comments about SME's, that they adopt technology just by chance with no formal planning procedure. Jocumsen (2004) details the links between strategic marketing decision making processes, the quality of those decisions and the performance of the organisation. Jocumsen (2004) argues that decision makers in SME's 'tend

to make extensive use of learned competencies in the form of 'perceived' rationality and the use of rudimentary analytical tools as well as the 'extensive use of inherent competencies mostly in the form of intuition and gut feel'. Pease and Rowe (2003) postulate that Australian SME's adopt innovation if forced to by outside forces or just by chance rather than the result of a strategic decision.

Strategies adopted to gain the desired future business-to-business infrastructure

The respondents were asked an open-ended question, on what strategies their organisation planned to adopt to gain their desired business-to-business communications infrastructure, in question 29. A definition of an information systems strategic plan is provided by Satzinger, Jackson and Burd (2000, p. 14) and reads "*The plan defining the technology and applications the information systems function needs to provide to support the organisations strategic plan*".

A content analysis was carried out on the responses and six main themes emerged:

- No plans for change
- Don't know
- Driven by trading partners
- Monitor new developments
- An upgrade of technology is planned
- A strategy in place

A total listing of responses is contained in Appendix B.

No plans for change

This was the largest group of responses containing 62 responses, examples of the comments made were:

- “Need increased growth before it becomes an issue”
- “Don't have any strategies and still waiting for trading partners to catch up with Internet use”
- “No strategies - cannot see B2B being useful in the near future”

All the organisations who responded that they had no plans for change employed fewer than 100 employees.

Don’t know

There were seven responses in this theme, all the respondents’ organisations employing fewer than 100 employees. Examples of these comments were:

- “Not sure - At this stage, knowledge of systems too limited so maintaining status quo - business is growing and possibly need to consider more professional help in this area”
- “Not quite sure”
- “Unsure determined by NZ”

Driven by trading partners

There were six responses in this theme. All the respondents' organisations employed fewer than 100 employees, one from the 1 – 4 category, one from 5 – 19 category and four from the 20 – 99 category. This follows Angeles (2000) findings that the balance of power was often skewed in favour of one trading partner and Jun and Cai's (2003) study which showed that most adopters of EDI are forced to by trading partners. In this case organisations are having their communication strategy dictated by trading partners. Instances of comments made are listed below:

- "Talk to suppliers and customers about their systems and see if we can be compatible with them"
- "reaction to future needs/ shortfalls"
- "This would be dictated by our trading partners"

Monitor new developments

There were seven responses in this theme, all the respondents' organisations employing fewer than 100 employees. Examples of the comments are:

- "Keep up to date with technologies, trends, hardware"
- "Constant discussions and communication with IT and communication providers to stay abreast of technology"
- "Monitor the IT news and discuss with our consultant for our database"

Upgrade of new technology planned

Eighteen responses were made following this theme, three responses from the 1 to 4 employee category, ten responses from the 5 to 9 employee category, three responses from the 20 to 99 employee category and two responses from the 200 plus employee category. Examples of the responses are listed below:

- “Website upgrade”
- “faster connection to email”
- “Upgrade computer network, install document centre - direct email etc”

All these responses could be considered to be an objective, or a specific thing that an organisation wants to achieve rather than a strategy.

Strategy in place

There were 18 responses, where the respondents indicated that their organisation maintained a strategic plan. Four responses from the 5 to 9 employee category, five responses from the 20 to 99 employee category, six responses in the 100 to 199 category and three responses from the 200 plus employee category. Examples of the responses are listed below:

- "Our company will always have a communication framework and we are developing and have developed applications that allow us to communicate fax, email and e-commerce"
- "Periodic review"
- "We are developing our systems so that we can use EDI with our major customer base"

All the organisations employing over 100 employees who answered this question either had set objectives that they wished to meet or had a strategic plan in place. This confirms Jocumsen's (2004) and Scupola's (2002) comments discussed in the previous section, that SME's fail to plan.

Table 13 shows the data relating to the size of the business and whether they use EDI.

	The organisation uses electronic data interchange							
	Yes		**No**		**Don't know**		**Total**	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	1	0.4	63	26.5	6	2.5	70	29.4
5-19	6	2.5	65	27.3	5	2.1	76	31.9
20-99	9	3.8	58	24.4	6	2.5	73	30.7
100 - 199	3	1.3	7	2.9	0	0	10	4.2
200 or more	5	2.1	3	1.3	1	0.4	9	3.8
Total	24	10.1	196	82.4	18	7.5	238	100

Table 13. Use of electronic data interchange compared with the employment size of organisation

There is again a relationship between employment size and the use of EDI. Also despite the definition of EDI being included in the glossary of the questionnaire, 18 respondents (7.5%) including one respondent from an organisation employing over 200 employees were not sure if they used EDI or not. For organisations employing 1-4 employees, 1 respondent (1.4%) used EDI. For organisations employing 5-19 employees, 6 respondents (7.9%) used EDI. In organisations employing 20-99 employees, 9 respondents (12.3%) used EDI. In organisations employing 100-199 employees, 3 respondents (30.0%) used EDI and for organisations employing over 200 employees, 5 respondents (55.5%) used EDI.

This data illustrates that for traditional EDI to be an important part of an industry the organisation must be of a size to employ at least 100 people. The barriers of cost, complexity and lack of technical skills are acting to stop SME's from gaining the increases in productivity that EDI can bring. A number of comments were made on the survey such as "Personal contact with business partners remains a priority, higher than that of other impersonal communications" and "The need for face to face contact to establish better feelings and relationships" that indicated that respondents were afraid of losing personal contact with trading partners by using electronic forms of communication.

Those respondents, who did not already use EDI, were asked in question 21 if they would consider using EDI. The results are presented in Table 14.

	Would the organisation consider using EDI?							
	Yes		No		Don't know		Total	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	11	5.5	38	19.0	14	7.0	63	31.5
5-19	13	6.5	33	16.5	21	10.5	67	33.5
20-99	18	9.0	23	11.5	19	9.5	60	30.0
100 - 199	5	2.5	0	0	2	1.0	7	3.5
200 or more	2	1.0	0	0	1	0.5	3	1.5
Total	49	24.5	94	47.0	57	28.5	200	100

Table 14. If the organisation would consider using electronic data interchange compared with the employment size of business

The above table shows that 24.5 per cent of respondents' organisations would be prepared to consider using EDI at some time, with a further 28.5 per cent being unsure if they would consider using EDI. These two groups contained all those organisations employing over 100 employees who did not use EDI now. Of the remaining 47 per cent who would not consider using EDI, 25.5 per cent employed less than 20 employees, with the remaining 11.5 per cent being in the 20 to 99 employee group.

Table 15 shows the data relating to the size of the business and whether they use SCM. There is again a relationship between employment size and the use of SCM. The definition of SCM was included in the glossary of the questionnaire, but 24 respondents (10%) were not sure if they used SCM or not. For organisations employing 1-4 employees, 3 respondent (4.3%) used SCM. In organisations employing 5-19 employees, 6 respondents (7.8%) used SCM, an identical number to those using EDI. For organisations

employing 20-99 employees, 4 respondents (5.4%) used SCM. In organisations employing 100-199 employees, 2 respondents (22.2%) used SCM and for organisations employing over 200 employees, 3 respondents (33.3%) used SCM.

	The organisation uses supply chain management							
	Yes		No		Don't know		Total	
Business size (Number of employees)	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
1-4	3	1.3	61	25.5	6	2.5	70	29.3
5-19	6	2.5	64	26.8	7	2.9	77	32.2
20-99	4	1.7	61	25.5	9	3.8	74	31.0
100 - 199	2	0.8	6	2.5	1	0.4	9	3.7
200 or more	3	1.3	5	2.1	1	0.4	9	3.8
Total	18	7.6	197	82.4	24	10.0	239	100

Table 15. The organisation uses supply chain management compared with the employment size of the organisation

This data shows that for this industry SCM has a lower priority than traditional EDI with 3 respondents (33.3%) using SCM compared to 5 respondents (55.5%) using EDI for organisations employing more than 200 employees. As the use of EDI implies the use of SCM, with EDI being used to improve cross institutional information flow and therefore tighten the supply chain, this finding indicates that there is uncertainty about the function of supply chain management. Management of the supply chain is done with the intent of improving customer service levels, cycle time reduction, increased inventory turnover leading to agile supply chains (Christopher & Towill 2000). Improvements in these functions increase the effectiveness of business

processes leading to improved organisational performance (Power & Sohal 2002; Prem PremKumar 2003).

In a study done by Fawcett and Magnan (2002) 88 percent of all respondents rated supply chain management as a critical business strategy. One of the drivers for the adoption of SCM detailed by Handsfield and Nichols Jr (2002) is that of the need to continually reduce cost throughout the supply chain. A number of comments were made on the questionnaire that one of the business issues being currently faced is market share decrease and profit decline, and yet this realisation has not been translated to an increased interest in SCM.

Information Technology Governance

IT governance is defined by Ward and Peppard (2002, p. 46) as "*how the authority for resources, risk, conflict, resolution and responsibility is shared among business partners*". Attitudes to IT governance now and in the future were tested in question 16. In the following table a correlation between responses to the issues now and in the future are detailed. It was decided to use the common practice of using the parametric test of correlation rather than the non-parametric test of Chi-square test for independence. The results from this question are not strongly skewed and there is a reasonable sample size, the data also fails to maintain the level of five counts (Zikmund 2003) necessary in each cell for the chi-square test for independence (Jamieson 2004). The high correlation between responses to the now question and the future question demonstrates that the respondents did not differentiate

between issues of IT governance now and in the future. The correlations shown in table 16 are all significant at the 0.01 level (2-tailed).

Issue	Period	Number	Pearson Correlation
Security of data while it is being transmitted is important in our organisation.	Now	237	.883
	Future	231	
The security of our stored data is a priority in our organisation.	Now	237	.933
	Future	211	
The authentication of the sender of a message is an important issue in our organisation.	Now	235	.910
	Future	229	
The volume of email received is a concern in our organisation.	Now	234	.773
	Future	226	
Control of spam is a concern in our organisation.	Now	234	.892
	Future	231	
That the originator of an electronic message cannot deny authorship at a later date (Nonrepudiation) is a concern in our organisation.	Now	228	.929
	Future	224	
The integrity of our data is a priority for our organisation.	Now	234	.868
	Future	230	
Complying with privacy regulations is a concern in our organisation.	Now	235	.933
	Future	231	
Complying with changing communication standards is a concern in our organisation.	Now	235	.868
	Future	231	
Meeting trading partner's technical requirements is a burden for our organisation.	Now	234	.746
	Future	230	
Maintaining the availability of our communication service is a priority in our organisation.	Now	236	.841
	Future	232	
The required bandwidth for communication is readily available.	Now	234	.810
	Future	230	
The cost of providing the required bandwidth for communication is a concern in our organisation.	Now	233	.881
	Future	228	
Maintaining protection against malicious software (viruses, worms, Trojan horses etc) is a priority for our organisation.	Now	236	.879
	Future	233	
Gaining industry agreement for a standard used to describe products is a concern in our organisation.	Now	236	.866
	Future	230	
Gaining industry agreement on communication standards is a concern in our organisation.	Now	236	.963
	Future	231	
Lack of interoperability (ability of different types of computers, networks, operating systems and applications to work together effectively) is an issue for our organisation's information system.	Now	230	.890
	Future	227	

Table 16. Correlation between IT governance issues, now and in the future

Exploratory factor analysis

There were two questions in the questionnaire which tried to measure organisations' attitudes on which exploratory factor analysis was carried out, question 13 and question 16.

It is likely that multiple dimensions of views are conceptually related, MacCallum (1998) stating that there is seldom a valid reason for assuming that underlying constructs are unrelated. Using an oblique rotation is appropriate when the theory shows a relationship between the constructs rather than orthogonal rotation which assumes no correlation.

Principal axis factoring and oblique rotation was used for the exploratory factor analysis. Five aspects were considered in conjunction to determine the number of factors to retain. First the scree plot was examined, eigenvalues over one, the percentage of variance explained, the simple structure and finally a theory driven approach (Gardner 2005).

Question 13 Attitudes toward information technology and communication

Question 13 looks at how an organisation views information technology. For question 13, the scree plot suggested two factors, backed up by two factors having eigenvalues over one explaining 47.767% of the variance. A three factor solution was considered but the simple structure showed that this

approach led to split loadings. A two factor solution showed the best simple structure and agrees with theoretical consideration.

The Kaiser-Meyer-Olkin measure of sampling adequacy was used to measure the factorability of the data and a value of 0.724 was gained. This value is above 0.6 the value at which data is considered factorable (Gardner 2005).

Results

Exploratory factor analysis using SPSS version 12.0.1 was conducted, using an oblique rotation beginning with the original eight variables. Variables which did not meet the criteria of loading 0.4 on the primary factor and less than 0.3 on the secondary factor were excluded. The variable “Recruiting and developing information systems staff is difficult for our organisation” was excluded on the basis that it loaded .006 on the first factor and -.230 on the second factor. This process resulted in a two factor solution, with four variables loading on the first factor and three on the second factor as illustrated in Table 17.

Loadings less than 0.3 have not been entered to make the simple structure easier to identify. The first factor appeared to be a measure of the organisation’s attitude to information technology, while the second factor appeared to be a measure of the organisation’s attitude to business-to-business communication.

Pattern Matrix(a)

	Factor	
	1	2
Does your organisation consider themselves technically innovative?	.766	
My organisation uses information technology to gain competitive advantage in the market place?	.743	
Does your organisation regularly consider adopting new forms of communication?	.651	
In my organisation money spent on information technology is money well spent.	.558	
My organisation would be more effective if information flows between it and our trading partners were integrated?		-.747
My organisation would be more effective if we developed better relationships with our trading partners		-.626
My organisation uses most effective means to communicate with our trading partners.		.441

Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.
A Rotation converged in 6 iterations.

Table 17. How the organisation views information technology (Q13)

As a reliability check of the scale, Cronbach's alpha was calculated, with a measure greater than 0.7 being considered to have acceptable reliability (Gardner 2005). Cronbach's alpha for this scale was 0.703.

Question 16 IT Governance

Question 16 looks at information technology governance and organisations' attitudes toward it, both now and in the future. Due to the strong correlation between now and future responses discussed above, the exploratory factor

analysis was carried out on the data from the responses to the now questions. An exploratory factor analysis was also carried out on the responses to the future questions which showed the same factor structure as the first analysis with the exception of the "Maintaining the availability of our communication service is a priority for our organisation now" which moved from loading weakly on the second factor to being split between the two factors. The scree plot suggested two factors, while four factors had eigenvalues over one explaining 43.99% of the variance. A four and three factor solution was considered but this led to unclear results with split loadings. A two factor solution showed the best simple structure and agrees with theoretical consideration, the two factor solution explaining 34.71% of the variance.

The Kaiser-Meyer-Olkin measure of sampling adequacy was used to measure the factorability of the data and a value of 0.81 was gained. This value is above 0.6, which is the value at which data is considered factorable (Gardner 2005).

Results

Exploratory factor analysis using SPSS version 12.0.1 was conducted, using an oblique rotation beginning with the original 17 variables. Variables which did not meet the criteria of loading more than 0.3 on the primary factor and less than 0.3 on the secondary factor were excluded. The variable "The volume of email received is a concern in our organisation" was excluded on

the basis that it loaded 0.240 on the first factor and 0.287 on the second factor. The variable “Complying with privacy regulations is a concern in our organisation” was excluded on the basis that it loaded 0.390 on the first factor and 0.355 on the second factor. The variable “The required bandwidth is readily available” was excluded on the basis that it loaded 0.218 on the first factor and 0.033 on the second factor. This process resulted in a two factor solution, with seven variables loading on the first factor and seven on the second factor as illustrated in Table 18.

Loadings less than 0.3 have not been entered to make the simple structure easier to identify. The first factor appeared to be a measure of the organisation’s attitude to complying with information systems standards, while the second factor appeared to be a measure of the organisation’s attitude to information systems security.

As a reliability check of the scale, Cronbach’s alpha was calculated with a measure greater than 0.7 being considered to have acceptable reliability (Gardner 2005). Cronbach’s alpha for this scale was 0.82.

Pattern Matrix

	Factor	
	1	2
Gaining industry agreement for a standard used to describe products is a concern in our organisation now.	.740	
Gaining industry agreement on communication standards is a concern in our organisation now.	.737	
Lack of interoperability is an issue for our organisations information systems now	.701	
Meeting a partners technical standards is a burden for our organisation now.	.573	
The cost of providing the required bandwidth for communication is a concern for our organisation now.	.472	
Complying with changing communication standards is a concern for our organisation now.	.423	
That the originator of an electronic message cannot deny authorship at a later date (nonrepudiation) is a concern in our organisation now.	.371	
Security of data while it is being transmitted is important in our organisation now.		.801
Security of stored data is a priority in our organisation now.		.747
The authentication of the sender of a message is an important issue in our organisation now.		.632
The integrity of our data is a priority for our organisation now.		.570
Control of spam is a concern in our organisation now.		.438
Maintaining protection against malicious software (viruses, worms, Trojan horses etc) is a priority for our organisation now.		.391
Maintaining the availability of our communication service is a priority for our organisation now.		.356

Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization.
a Rotation converged in 10 iterations.

Table 18. Organisations' attitude to information technology governance

Analysis of Variance

A bivariate analysis of variance was carried out on questions 13 and 16 using the weighted scores derived from the factor analysis described above. The analysis of variance was carried out to determine if there was a significant difference in the factors dependent on the employment size grouping of the organisation. A one-way analysis of variance was carried out using the independent variable employment size.

Question 13 Attitudes toward information technology and communication

Table 19 is an analysis of variance summary table. This table and the descriptive table following, result from the analysis to see if there is a significant difference in the means of the two factors detailed in the factor analysis. These factors are the organisation's attitude to information technology and the organisation's attitude to business-to-business communication dependent on to which employment size category the organisation belongs.

ANOVA						
		Sum of Squares	df	Mean Square	F	Significance
IT Attitude factor score	Between groups	11.444	5	2.289	2.949	.013
	Within groups	177.738	229	.776		
	Total	189.182	234			
B2B communication attitude factor score	Between groups	10.754	5	2.151	3.003	.012
	Within groups	164.037	229	.716		
	Total	174.791	234			

Table 19. ANOVA of attitudes toward information technology and communication

Table 20 is of the descriptive information for attitudes toward information technology and communication. The assumptions for Analysis of Variance (ANOVA), that of normality of the sample and homogeneity of variance, were tested. The normality of the sample was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests represented in table 21. The Kolmogorov-Smirnov test showed a departure in normality for the 200 or more employee's category for the IT attitude factor score (K-S(8) = .299, p = .034), with the Shapiro-Wilk test showing no significant categories. On examining the boxplot for the 200 or more employees' category for the IT attitude factor score for skewness and kurtosis the category was found to be skewed to the left so that the ANOVA results for this category must be viewed with caution.

Descriptives Question 13									
						95% Confidence Interval for mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minium	Maximum
IT Attitude factor score	1-4	65	-.2368	.9361	.1161	-.4688	-.0049	-2.130	1.496
	5-19	78	.0563	.9621	.1089	-.1606	.2730	-2.294	2.153
	20-99	73	.0231	.7957	.0931	-.1625	.2088	-2.555	1.478
	100-199	10	.3010	.5505	.1741	-.0929	.6948	-.4949	1.026
	200 or more	8	.8748	.5434	.1921	.4204	1.329	.3670	1.763
	Missing	1	-.6966					-.6966	-.6966
	Total	235	.0000	.8991	.0586	-.1155	.1156	-2.555	2.153
B2B communication attitude factor score	1-4	65	.2158	.8778	.1089	-.0017	.4333	-2.133	2.193
	5-19	78	-.0624	.7877	.0892	-.2400	.1152	-1.616	2.028
	20-99	73	.0359	.8904	.1042	-.1718	.2437	-1.844	2.204
	100-199	10	-.6490	.5849	.1850	-1.067	-.2305	-1.358	.6855
	200 or more	8	-.5786	.9842	.3480	-1.401	.2442	-1.644	1.261
	Missing	1	-.6622					-.6622	-.6622
	Total	235	.0000	.8643	.0564	-.1110	.1111	-2.133	2.204

Table 20. Descriptive table of attitudes toward information technology and communication

Tests of Normality(b,c)

	Number of full time employees	Kolmogorov-Smirnov(a)		
		Statistic	df	Sig.
IT Attitude factor	1 - 4	.069	65	.200(*)
	5 - 19	.066	78	.200(*)
	20 - 99	.058	73	.200(*)
	100 - 199	.168	10	.200(*)
	200 or more	.299	8	.034
B2B attitude factor score	1 - 4	.096	65	.200(*)
	5 - 19	.082	78	.200(*)
	20 - 99	.074	73	.200(*)
	100 - 199	.228	10	.150
	200 or more	.163	8	.200(*)

	Number of full time employees	Shapiro-Wilk		
		Statistic	df	Sig.
IT Attitude factor	1 - 4	.973	65	.166
	5 - 19	.985	78	.505
	20 - 99	.974	73	.128
	100 - 199	.924	10	.387
	200 or more	.841	8	.078
B2B attitude factor score	1 - 4	.984	65	.573
	5 - 19	.982	78	.327
	20 - 99	.987	73	.681
	100 - 199	.873	10	.109
	200 or more	.920	8	.429

* This is a lower bound of the true significance.
a Lilliefors Significance Correction
b IT Attitude factor score is constant when Number of full time employees = 9. It has been omitted.
c B2B attitude factor score is constant when Number of full time employees = 9. It has been omitted.

Table 21. Descriptive tests of normality for attitudes toward information technology and communication

To test the homogeneity of variance assumption, a Levene Statistic was calculated. The null hypothesis for the Levene test is that the variances are homogeneous, so that if the statistic is not significant at the .05 level then the variances are homogeneous. For this sample the result for the IT Attitude factor score is Levene(4,229) = 1.464, p = .214, with the result for the B2B communication attitude factor score being Levene(4,229) = .890, p = .471.

These results are not significant so the null hypothesis that the variances are homogeneous can be accepted.

The one way analysis of ANOVA was significant for both variables at a significance level of 0.05 as detailed in the ANOVA table above, as an F-value greater than 2.21 is required to reject the null hypothesis that there is no difference between the employment size groups. This means that there is a significant difference in the attitudes of organisations in the sample to information technology and business-to-business communication dependent upon the employment size. For the attitude to information technology factor, the higher the employment bracket to which the organisation belonged, the stronger the organisation loaded onto the factor. This finding indicates that the larger organisations view information systems as more strategic than do SME's. In the attitude to business-to-business communication, the employment category which loaded most strongly on the factor was 100 to 199 employees, with those employing over 200 employees loading the least strongly. This result may indicate a flaw in the instrument construction, as the questions are slanted toward respondents believing their organisations would become more effective with better business-to-business communication. The respondents from the largest organisations may believe that their business-to-business communication is very effective and that very little improvement could be made.

Due to the factor score being generated from Likert scale data, which is ordinal not at least interval which is an assumption of the ANOVA test, a

Kruskal-Wallis test for non-parametric data was also carried out with the result of the right tail probability (.009 and .003) showing that the probability of the differences between the groups being caused by chance is less then .05. This means that the Kruskal-Wallis test values also reject the null hypothesis that there is no difference in the attitudes to information technology and business-to-business communication within the employment size categories.

Test Statistics(a,b)

	IT Attitude factor score	B2B attitude factor score
Chi-Square	13.556	16.062
df	4	4
Asymp. Sig.	.009	.003

a Kruskal Wallis Test
b Grouping Variable: Number of full time employees

Table 22. Test statistic for attitudes toward information technology and communication

These tests show a significant difference in attitude to information technology and business-to-business communication dependent upon the employee number category into which the organisation falls.

<u>Comments made on answers given to Question 13</u>

Twenty seven respondents made a comment on their responses to question 13. Two main themes emerged. The first theme with 13 responses was that the use of information technology to facilitate communication was not a priority. Some examples of these comments are:

- “The above question is not of great importance to the ongoing success or governance of our business”
- “These issues are well down the list of importance in our efforts to stay profitable”

All these comments came from organisations that employed less than 100 employees, with four comments being from organisations employing less than five employees, six organisations employing five to nineteen employees and the remaining three comments coming from organisations employing from twenty to ninety nine employees. This confirms that an organisation’s attitude to information technology is dependent on the employee size.

The second theme with seven responses was that their communication channels were driven by their customers. Some samples of these comments are listed below:

- “We would use email more, but our suppliers and customers do not facilitate this”
- “We are going down the e-commerce track with one of our suppliers and if that is successful we will push on and try and develop with our other suppliers”

These comments were spread across the range of employee size of the organisation, indicating that a lack of information systems infrastructure or

knowledge in trading partners form a barrier to the further development of the use of information technology in business-to-business communication.

Two respondents stated that they were in the process of upgrading their business-to-business systems:

- "Company is making a strong move forward implementing a system based on state of the art technology"
- "We are looking to become technologically innovative and gain a competitive advantage"

Both these comments came from SME's, with the first quotation coming from an organisation employing five to nineteen employees, the second quotation coming from an organisation employing 20 to 99 employees.

The full list of comments is supplied in Appendix C.

Question 16 Attitudes toward information systems standards and information system security

Table 23 is the analysis of variance summary table. This table and the descriptive table following result from the analysis to determine if there is a significant difference in the means of the two factors detailed in the factor analysis above. These factors are the organisation's attitude to information systems standards and the organisation's attitude to information systems security dependent on which employment size category the organisation belongs to.

ANOVA						
		Sum of Squares	df	Mean Square	F	Significance
IS standards attitude factor score	Between groups	2.871	5	.574	.689	.633
	Within groups	177.624	213	.834		
	Total	180.496	218			
IS security attitude factor score	Between groups	11.681	5	2.336	2.951	.013
	Within groups	168.603	213	.792		
	Total	180.284	218			

Table 23. ANOVA of attitudes toward information systems standards and information system security

Table 24 shows the descriptives of attitudes toward information systems standards and information system security. Assumptions for Analysis of Variance (ANOVA); that of normality of the sample and homogeneity of variance, were tested. The normality of the sample was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests represented in the table below. The Kolmogorov-Smirnov test showed a departure in normality for the 20-99 employee's category (K-S(68) = .143, p = .001) and 100-199 employee category (K-S(10) = .287, p = .001) for the information system standards compliance attitude factor score (K-S(68) = .143, p = .019), with the Shapiro-Wilk test showing these two categories and the 1-4 employee category as significant categories. On examining the box plots for these three employee number categories for the attitude toward compliance with information system standards factor scores for skewness and kurtosis the 20-99 and 100-199 categories were found to be skewed to the left so that the ANOVA results for these categories must be viewed with caution.

Descriptives Question 16									
						95% Confidence Interval for mean			
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minium	Maximum
Attitude to complying with information systems standards factor score	1-4	62	-.0501	.9633	.1223	-.2948	.1945	-2.274	2.854
	5-19	71	.0205	.7889	.0936	-.1662	.2073	-1.590	2.189
	20-99	68	-.0614	.9667	.1172	-.2954	.1725	-1.661	3.134
	100-199	10	.2270	.8963	.2834	-.4142	.8681	-.8283	2.224
	200 or more	7	.5216	1.126	.4257	-.5200	1.563	-.9208	1.883
	Missing	1	-.0939					-.0939	-.0939
	Total	219	.0000	.9099	.0615	-.1212	.1212	-2.274	3.134
Attitude to information systems security factor score	1-4	62	-.1469	1.049	.1332	-.4134	.1195	-3.095	1.229
	5-19	71	-.1857	1.014	.1203	-.4257	.0543	-2.704	1.238
	20-99	68	.3140	.5638	.0684	.1775	.4504	-.9299	1.882
	100-199	10	-.1313	.8117	.2567	-.7120	.4494	-1.174	1.141
	200 or more	7	.3649	.6140	.2321	-.2030	.9327	-.5329	1.144
	Missing	1	-.2928					-.2928	-.2928
	Total	219	.0000	.9094	.0614	-.1211	.1211	-3.095	1.882

Table 24. Descriptives of attitudes toward information systems standards and information system security

For the attitude to information systems security, the Kolmogorov-Smirnov test showed that there were no significant results so the null hypothesis that the distribution is normal cannot be rejected. The Shapiro-Wilk test for normality however shows that both the 1-4 and 5-19 employee numbers are significant so the null hypothesis is rejected for these categories. On examination of the boxplots for these categories a skew to the left is evident, so the ANOVA results for these categories must be viewed with care.

Tests of Normality(b,c)

	Num_Emp Number of full time employees	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
IS_Stds Attitude to complying with IS standards	0 1 - 4	.111	62	.056	.955	62	.024
	1 5 - 19	.093	71	.200(*)	.976	71	.188
	2 20 - 99	.143	68	.001	.957	68	.021
	3 100 - 199	.287	10	.019	.839	10	.043
	4 200 or more	.197	7	.200(*)	.914	7	.427
IS_Security Attitude to IS security	0 1 - 4	.105	62	.088	.927	62	.001
	1 5 - 19	.090	71	.200(*)	.940	71	.002
	2 20 - 99	.050	68	.200(*)	.992	68	.929
	3 100 - 199	.195	10	.200(*)	.915	10	.314
	4 200 or more	.197	7	.200(*)	.940	7	.642

* This is a lower bound of the true significance.
a Lilliefors Significance Correction
b IS_Stds Attitude to complying with IS standards is constant when Num_Emp Number of full time employees = 9. It has been omitted.
c IS_Security Attitude to IS security is constant when Num_Emp Number of full time employees = 9. It has been omitted.

Table 25. Tests of normality for attitudes toward information systems standards and information system security

To test the homogeneity of variance assumption a Levene Statistic was calculated. The null hypothesis for the Levene test is that the variances are homogeneous, so that if the statistic is not significant at the .05 level then the variances are homogeneous. For this sample the result for the Attitude to information systems compliance to standards factor score is Levene(4,213) =

1.103, p = .356, with the result for the attitude to information systems security factor score being Levene(4,213) = 5.685, p = .000. The result for the first factor is not significant so the null hypothesis that the variances are homogeneous can be accepted, however for the second factor, that of information systems security, the result is significant, so the second factor fails one of the assumptions necessary to perform analysis of variance.

The one way analysis of ANOVA was not significant for both variables at a significance level of 0.05 as detailed in the ANOVA table above. An F-value greater than 2.21 is required to reject the null hypothesis that there is no difference between the employment size groups. The F-score for the attitude to information systems compliance to standards was not significant which means the null hypothesis cannot be rejected. This means that there is no difference that may not be caused by chance dependent upon the employment size for this factor. The second factor, that of attitude to information security factor score, is significant so the null hypothesis could be rejected however the assumption of homogeneity of variance is not true for this factor. When the loadings are examined, the employment category loading most strongly on the factor is 20 to 99 employees.

Due to the factor score being generated from Likert scale data, which is ordinal not at least interval which is an assumption of the ANOVA test, and the failing of some of the necessary assumptions for an ANOVA test a Kruskal-Wallis test for non-parametric data was also carried out. The result of the right tail probability for the attitude to complying with information systems standards was 0.582 so that the null hypothesis cannot be rejected for this

factor meaning that the probability is that the differences between the employment size groups were being caused by chance. For the attitude to information systems security factor the result of the right tail probability is .039, so the null hypothesis that there is no difference in attitudes within the employment size categories can be rejected.

Test Statistics(a,b)

	Attitude to complying with IS standards	Attitude to IS security
Chi-Square	2.854	10.056
df	4	4
Asymp. Sig.	.582	.039

a Kruskal Wallis Test b Grouping Variable: Num_Emp Number of full time employees

Table 26. Test statistic for attitudes toward information systems standards and information system security

From this we can conclude that there is no significant difference within employee number categories for attitudes to information systems standards compliance, with any difference being caused by chance. For the second factor, that of attitude to information systems security, there is a significant difference between employee number categories.

4.4 Conclusion for questionnaire analysis

The study shows that the Australian timber and wood products industry is in line with current computer and Internet use compared to the report on the Australian industry as a whole. For both computer and Internet use there is a relationship between the employment size of a business and the use of

technology. The relationship between employment size and the means of accessing the Internet is the difference in the choice of connection means. The choice of connection moves from dial-up modems in small businesses, ADSL broadband with medium businesses in the tier 1 businesses and networking technologies with the larger tier 2 organisations. This question also showed that the industry was behind Australian businesses in general in the adoption of ADSL broadband. The questions on the maintenance of an information systems strategic plan and the use of EDI and SCM identified a lack of planning and a lack of awareness in the use of technology to support business objectives. The Australian timber and wood products industry has in general failed to use e-commerce to gain a possible competitive advantage in the marketplace. The industry is not therefore positioned to be able to take advantage of the benefits of e-commerce.

4.5 Ontology development

The following are examples of using Gruber's five principles of ontological quality, and the methods described in section 3.2.2 on the ontology prototype. As this is a mechanistic process, only a few examples using each principle are given.

To support clarity, the meaning of the data entities should be able to be understood by means of a formal definition. In the timber industry there is a convention that timber may be referred to in the dimensions that it had before being machined smooth, this is known as its nominal size. So in the timber

products ontology the entity of “NominalSize” should be defined clearly as the dimensions of the timber used for identification only, not the literal dimensions of the timber. The “Length” data entity is defined as “measurement of the object extents along its longest dimension.”

Cardinality constraints are introduced between data entities, for example between “CrossSection” and “Width”. The addition of the cardinality helps to make clear for organisations committing to the ontology that each piece of timber must have one “Width”. Cardinality is also introduced between “UnitOfSale” and its sub-classes, so each piece of timber sold must have one “UnitOfSale”.

The *part of property* helps to make the implicit relationship between classes such as “Attributes” and its sub-classes such as “Dimension” and “Dryness” explicit. This helps to clarify that the sub-classes form *part of* the *whole* that is the class “Attribute”. The relationship between “SI-system” and “Size” is also a *part of property.*

To assist clarity, the sub-classes that have been declared, for instance “Construction”, are defined rather than declared. In the example of “Construction” an attribute is created that specified if the construction was solid, finger jointed or was Medium Density Fibreboard (MDF), to reduce the number of unintended meanings drawn from the ontology.

For coherence, the inconsistency in how people refer to species of timber must be accommodated. So timber can be referred to by either by one of its

common names, for example *Slash Pine,* or its botanical name *Pinus elliottii.* A reasoning tool may have to be used to map from the common name to the botanical name.

To enhance the extendability of the ontology, entities for areas of future variability, for instance “Price” and “Discount” which are both used in calculating the price of a piece of timber, are separated, introducing flexibility. The different types of “Packs” are treated as sub-classes rather than an attribute, so that pack types can be changed or added to with minimal impact.

So that minimal encoding bias exists, the units used for measuring the dimensions of the timber products, and how a standard pack of timber for that organisation is quantified, must be unambiguous. For this ontology to avoid encoding bias a facility must be made for an organisation to specify how the dimensions of the timber are measured, and a reasoning tool used to show equivalence between how each organisation represents their timber. As this is a prototype of an ontology, no implementation detail imposing encoding bias is introduced, such as requiring that length be a double-float. This ontology is kept at the knowledge level (Gruber 1993b).

Currently the ontology is restricted to Australia due to restrictions in the “Species” class and the use is made of Australian standards to declare classes such as “Treatment” and “Grade”, increasing ontological commitment. These factors mean that for an overseas timber organisation to commit to this ontology the ontological commitment is high. A way of

lessening the level of ontological commitment for this ontology is to merge a separate species ontology detailing the timber species used in logging with this ontology to cover species outside of Australia.

The ontology description languages do not have a standard modelling tool to show a graphical representation of an ontology fragment. As discussed by Colomb (2005), Unified Modelling Language (UML) can be used to provide a visual representation of a portion of an ontology demonstrated in the model of the proposed timber ontology shown in Figure 20.

The ontology described in Figure 20 provides a basis for an Australian timber and wood product ontology. As a result of the open world assumption by both RDF and OWL this ontology can be extended to generalise the ontology to more organisations within the timber sector. The foundation of this ontology is a product listing provided by Hyne and Son Proprietary Limited which details categories that describe the organisation's 40 000 products. The products are organised into broad categories dependent upon timber attributes, and this forms a hierarchy of classes which can be used for machine processing and the semantic web or as a basis for an XML document.

The classes, properties and instances in this model can be explicitly defined by using OWL. As OWL is based on XML it is verbose so that it is not possible to show the whole ontology. Examples of a class and the

namespace declaration are given using the OWL representation of the model. The OWL shown below was generated by Protègè, used in conjunction with the reasoner Racer. A standard initial part of an ontology is the namespace declaration as shown in Figure 19.

```
<?xml version="1.0"?>
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns="http://www.owl-ontologies.com/australianTimber.owl#"
  xml:base="http://www.owl-ontologies.com/australianTimber.owl">
```

Figure 19. OWL namespace declaration

The namespace declaration allows for the means to interpret identifiers unambiguously. The line below from within the namespace declaration states that any unprefixed qualified names refer to the current ontology.

xmlns=http://www.owl-ontologies.com/australianTimber.owl#

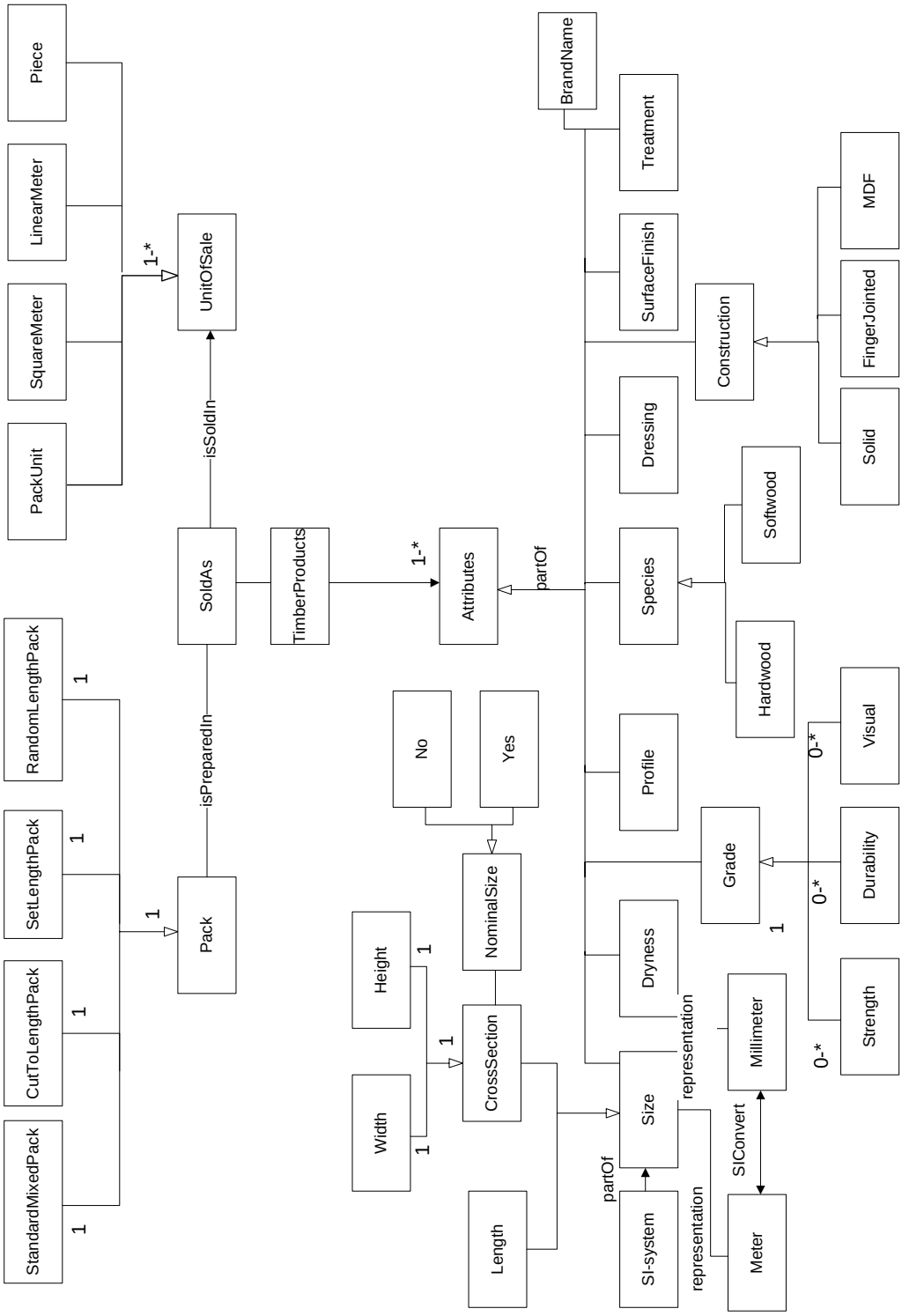

Figure 20. A model of an ontology for the Australian timber and wood products industry

Figure 21 gives the OWL representation of the Profile class within the Australian Timber ontology, showing that it is disjoint from other classes, a subclass of Attribute and showing how an instance is defined with the rdf:ID syntax.

```
<owl:Class rdf:about="#Profile">
        < owl:disjointWith>
< owl:Class rdf:about="#Size"/>
</ owl:disjointWith>
< owl:disjointWith rdf:resource="#Construction"/>
        < rdfs:subClassOf rdf:resource="#Attributes"/>
        < owl:disjointWith rdf:resource="#Grade"/>
        < owl:disjointWith rdf:resource="#Seasoning"/>
        < owl:disjointWith rdf:resource="#Species"/>
        < owl:disjointWith rdf:resource="#SurfaceFinish"/>
        < owl:disjointWith rdf:resource="#Dressing"/>
</owl:Class>
<Profile rdf:ID="Batten"/>
<Profile rdf:ID="Fascia"/>
<Profile rdf:ID="DoubleRebatedSawnNoiseBarrier"/>
<Profile rdf:ID="Cladding"/>
<Dressing rdf:ID="DressedOneSide"/>
<Profile rdf:ID="SingleRebatedSawnNoiseBarrier"/>
<Profile rdf:ID="Decking"/>
```

Figure 21. OWL representation of the Profile class

The complete OWL representation of the ontology is presented in Appendix D.

5.0 Conclusions and implications

5.1 Introduction

This thesis discusses how the Australian timber and wood products industry uses information communication technologies, both within an organisation and in business-to-business communications. Issues surrounding building an ontology and the first stage of a domain specific ontology for this industry are also discussed. The purpose of this thesis is to better understand the industry's capacity to adopt a more technology intensive approach to communication within the supply chain. The research question was

> *How do organisations in the Australian Timber Industry manage business-to-business communication in the supply chain currently and in the future and the characteristics and an open standard for electronic communication within the industry?*

In Chapter two, literature on information sharing, e-business enabling technologies, supply chain management and the semantic web was examined to look at the factors affecting the adoption of information technology enabled means of communication.

Chapter three describes the research methodologies used for data collection. A self-administered mail questionnaire was developed in order to gain a snapshot of how the Australian timber and wood products industry is using information technology in communication. A content survey was conducted

on the product listing for Hyne and Son Proprietary Limited to develop a foundation for an ontology.

Chapter four contains the data analysis from the mail questionnaire using the statistical and data management software system SPSS. Descriptive statistics from the sample and factor analysis were carried out on factorable questions. A number of the factors were looked at from the point of view of the employment size of the organisation. The program Protégé was used to engineer the ontology, with the visual representation drawn in Microsoft Visio.

In this chapter, conclusions are drawn regarding the research question and the related sub-questions.

5.2 Conclusions for the research issues

5.2.1 Questionnaire

The first section of the questionnaire was designed to gather demographic information on the industry, and this information showed that 92.1% of the organisations in the sample employed less than 100 employees. This means that the industry has a large pool of SME's in its domain. Most of the respondents' organisations were in the timber products manufacturing or timber merchandising sectors, these sectors forming 60.4% of the sample.

The first sub-question which was posed in the research question is below:

How do the organisations define business-to-business communication? This question was posed in the questionnaire, but due to a flaw in the construction of the questionnaire discussed in section 4.2, no conclusion was able to be drawn from the data gathered.

The second sub-question is what system of business-to-business communication do they currently use? Use of computers in the business was found to be extensive with 95% of respondents using a computer in their business. Computer use became ubiquitous once the employment size of the organisation reached over 100 employees. Computer use in the Australian forest and wood product industry was comparable with other Australian industry sectors, while employment size of the organisation affected whether they were likely to use computers. Internet usage followed the same pattern, with 4% of respondents using a computer in the business without Internet access. The type of Internet access that is used is dependent upon the employment size of an organisation, with the importance of broadband Internet access increasing with the size of the organisation.

For both intrabranch and business-to-business communication the communication channels most frequently used are the established ones of postal service, telephone or facsimile, however when advanced information technology is available such as a LAN or leased data line then that service is used constantly. The use of EDI is currently very dependent on the employment size of the organisation, with use of EDI increasing as employment size increases. The data showed that for the current model of

EDI to form an important part of an organisation's business-to-business strategy, the organisation must be growing toward a large organisation and employ over 100 people. The organisations which fit this profile in the sample would consider EDI as an important strategy, if not currently using EDI. In the study discussed in section 2.2.6 Jun & Cai (2003) found that it was pressure from trading partners that led to the adoption of EDI, the results from this survey show that there may be an absence of pressure from larger organisations for SME's to adopt EDI.

A formal supply chain management strategy does not yet play a large role in the industry, with only 7.6% of organisations actively having the technology in place. The Australian Timber and Wood Product industry does not align with the results from other studies such as that discussed in section 2.0.2 where supply chain management was found to be a critical business strategy. However in the Fawcett and Magnan (2002) study, organisations were chosen to participate based on their reputation for progressive SCM.

It was not possible to differentiate between the following two sub-questions, with a strong correlation between issues the respondents considered important now and in the future being discussed in the results section.
What issues do they have with business-to-business communication now?
What issues do they see as critical for future business-to-business communications?

The use of factor analysis and analysis of variance showed that there is a difference in attitude toward information technology, business-to-business communication and information systems security, dependent upon the employment size of the organisation. The fourth factor, that of attitude toward information systems compliance to standards, was found to be not dependent upon employment size.

For the factor of attitude to information technology, it was found that the bigger the organisation, the more strongly the organisation loaded on the factor. This indicates that the bigger organisations have identified information technology as a strategic asset.

With the factor of attitude to business-to-business communication, it was found that organisations in the 100 to 199 employment category loaded most strongly, while the employing over 200 category loaded the least strongly. This result indicates a limitation of the instrument, as the questions may not have recognised that these larger organisations feel that their business-to-business communication strategy is sufficient, with little room for improvement.

The factor which relates to the attitude to information security found that the organisations employing 20 to 99 employees was the strongest loading cohort, followed by the 100 to 199 employment category. The results indicated that organisations in the 20 to 99 employment category have invested in information technology and are concerned and aware of

information security, but may not feel that policies are in place to counteract any threat. For the 100 to 199 employment category, and to a greater extent the employing over 200 category, the organisations may feel that although information technology is a concern their investment in information technology is protected by adequate security.

When the respondents were asked an open-ended question on the issues important in business-to-business communication, six themes emerged which can be further reduced to three themes, that of problems in gaining the desired functionality from their communication service or not having enough resources to devote to information technology. The second theme was that the building of a relationship between businesses was the priority. The third theme was that these questions were either not applicable or not important. These comments identify the action of three barriers to the adoption of technology intensive communication channels, location, cost of service or lack of resources and organisational size. These results back the findings discussed in section 2.2.6 where previous studies have shown that cost and a lack of resources act as a barrier.

Comments made on how the organisation views information technology showed two themes, the first being that using information technology to facilitate communication was not a priority; the second theme was that communication was driven by the customers. The barriers identified in these comments are organisational size and a lack of momentum in the diffusion of

the innovation leading to a lack of drivers toward the adoption of e-technologies within SME's (Fillis, Johannson & Wagner 2004).

The following sub-question was explored using both a fixed alternative and an open-ended question:

What strategies do they suggest to gain the desired future business-to-business communication functionality?

The results showed that the likelihood of an organisation maintaining an information systems strategy plan increases with employment size. The open ended question showed that while organisations in the 20 to 99 employee category may not maintain a formal plan, they have begun to set objectives that they wish to achieve for their information systems, which confirms Jocumsen (2004) findings that, rather than a formal strategy, managers of SME's tend to make judgement calls based on their intuition rather than having long term planning strategies in place. As discussed in section 2.2.4, one of the critical success factors for successful collaboration in the supply chain is a clear vision of the goals for the supply chain (Wong 1999). The lack of planning identified here operates as one of the barriers to the successful adoption of e-technologies.

5.2.2 Ontology

The last sub-question of the research question is, what comprises a standard library of elements that will describe attributes of timber and wood products in

business-to-business communication? This resulted in the construction of a prototype of a domain specific ontology for the Australian timber and wood products industry.

This is a prototype or first stage in the development of an open standard domain specific ontology for the Australian timber and wood product industry, as no domain ontology existed. The ontology makes an open world assumption so that this prototype will grow and gain depth with interaction and input from other domain members. The development of this ontology gives the industry a number of options. The ontology provides a path for the industry to be part of the semantic web movement, both now and in the future. The ontology's extensibility allows the ontology to evolve to reflect current needs, so that investment in the adoption of the ontology and semantic technologies carries long term benefits.

The ontology may also be used in the web-based EDI paradigm, providing a common set of data elements that sits outside any one organisation. Each organisation may map to that ontology, rather than having to map to individual organisations' representations. This gives the ability to maintain a loosely coupled connection between trading partners. This introduces flexibility into the connection so that changes in one organisation's information system or data representations does not impact on the trading partner's information system increasing maintenance costs. The ontology provides the means to bring the advantages of EDI to SMEs, while lowering the traditional barriers of technical complexity and high implementation and

maintenance costs. Web based EDI facilitated by the ontology provides a path for organisations to exchange real time data across organisational boundaries bringing the productivity gains and tighter supply chain that this enables.

The adoption of a timber and wood product ontology coupled with a flexible open management approach, for instance the adoption of a framework such as BizDek discussed in section 2.2.2, allows an organisation to participate in productive cross institutional information flows. When a timber and wood product organisation has the ability to receive and send transparent supply chain information in real time, within the confines of available resources, that organisation has the ability to realise productivity gains. This ability promotes the formation of strategic alliances with trading partners, gaining a competitive advantage for this virtual organisation, and increasing productivity.

5.3 Conclusions for the research problem

5.3.1 Implications from survey

The survey confirmed that the Australian timber and wood products industry was made up of two tiers. There were few tier one organisations employing over 200 employees and a larger proportion of tier two organisations or SME's employing less than 200. These two tiers have different needs and approaches to the adoption of information systems. The Small Enterprise

Telecommunications Centre Limited (SETEL) (2001) calls this gap between the adoption of e-business by tier one organisations and tier two organisations, the other digital divide. SETEL indicates that in their view SME's are not gaining an equal range of benefits from online opportunities.

Barriers to the adoption of an e-business strategy in this industry identified in the study are that of geographic location, lack of resources, lack of knowledge and lack of planning. Some sectors of the industry, such as forestry growing and management and sawmilling are located in regional areas, where services such as a high-speed Internet connections are not available at an affordable price, or drivers such as local community based competition or pool of innovation are not available (Pease & Rowe 2002). These identified barriers coupled with, as discussed in section 1.3.1, a fragmented industry with a poor sense of identity present an environment which is not optomised toward collaboration in the adoption of e-business (Pease & Rowe 2002). This environment will be an obstacle to forming a collaborative industry group driving technological advances in business-to-business communication.

A lack of resources was identified as a barrier, with these resources including time, knowledge and the perceived cost of the implementation. The lack of time to become familiar with the current demands of business-to-business communication and plan implementation is a barrier in SME's as identified by Brown (2002). The lack of knowledge or technical complexity was identified as a barrier, confirming the findings by Fillis, Johannson and Wagner (2004)

and may be a product of the organisational size and the lack of time. In the comments by the respondents cost was identified as a barrier, and this confirms the findings by Angeles (2000) discussed in section 2.2.6.

A lack of formal planning in SME's in the study is a barrier, as a clear vision is necessary to drive the successful adoption of information systems plans (Wilson & Deans 2000). The long term business planning and the planning for information systems to support the business strategy come from the owner/ manager (Fillis, Johannson & Wagner 2004).

Methods to overcome these barriers are discussed by Scupola (2002) and Brown (2002). As discussed in section 2.0.1 SME's may not be aware of the benefits provided by ecommerce and Internet technologies (Mullins, Duan & Hamblin 2001), so education has a role to play in driving the adoption of e-business. The importance of educating owner/managers in the advantages of EDI was highlighted by Parker and Swatman (1996), who also stated that full benefits from adopting e-business could not be attained by tier one organisations until tier two organisations also adopted. Scupola (2002) gives as examples of needed education the funding of research projects and the provision of training programs to build up skill levels in the industry. Brown (2002) states there is a need to demystify and simplify the process of automatic business-to-business communication, to make it accessible to time poor owners and managers. Industry associations have a role to play in becoming champions and supporters of the adoption (Brown 2002), with the adoption of standards for the industry also playing an important part.

The questionnaire has highlighted the need for this industry to support the adoption of a standard simplified, low cost package for electronic business-to-business communication, particularly aimed at those organisations employing 20 to 99 employees. This category has the resources to develop information systems as an enabler of innovation and competitive advantage shown by the number of organisations in this category having made objectives for their information systems. Wide spread adoption in this category would help to build bandwagon pressure described by Lee and Chan (2003) as a pro-innovation bias assumption. However the barriers identified in the survey will need to be overcome or diminished before the introduction of wide-spread electronic business-to-business communication can be successful.

5.3.2 Implications from ontology development

Taking advantage of the opportunities that semantic technologies and the provision of this domain specific ontology generates for improved information technology systems presents a number of challenges to management of the Australian Timber and Wood products industry. One of these challenges is the need to form strategic alliances with trading partners who recognise the need to commit to an external ontology, thereby giving up some autonomy (Colomb 2005). Semantic technologies make strategic alliances more achievable due to the improved cross organisational information flows allowing the exchange of real time business data. An atmosphere of trust as

discussed in section 2.1.5 must exist for alliances to function successfully, however it has not been demonstrated that this atmosphere exists in the industry, forming a barrier to gaining the advantages of a strong strategic alliance.

Increased proficiency in handling information flows has been shown to bring competitive advantage to an organisation (Levy, Loebbecke & Powell 2001). Business processes may need to be changed and translation software employed to meet the ontology requirements, but alliance partners internal processes are then no barrier to interoperability. The freedom from the need to have tightly coupled information systems with multiple trading partners that this ontology provides offers the potential to reduce maintenance costs. McComb (2005, p. 6) suggests that "*corporations typically spend 35 to 65% of their budgets on integration and interoperation*".

Semantic web technologies offer the opportunity of integrating with one external, extendible and flexible ontology or standard, potentially lowering integration costs. A disadvantage to the semantic technology approach is that there must be consensus within the strategic alliance to the same domain specific ontology. This consensus may be difficult to gain in the Australian timber and wood products industry, and may need to be driven by an industry group such as the Hardware Industry Work Group discussed in section 2.2.2. Williams, Krygowski & Thomas (2002) propose the use of intelligent agents to reach ontology consensus. This may require management to adopt a new way of thinking, planning and operating focusing on the benefits offered by collaborative commerce (Walters 2004)

and using information systems as an enabler for this co-opetition. Co-opetition is the result of the formation of virtual organisations with partners concurrently cooperating and competing in the same marketplace (Rowe & Pease 2005).

A focus on collaboration within an industry sector rather than competition is driving the need for the need for a shift in management style and focus. Co-opetition demands a move away from an internally focused approach, for instance focusing on access to and use of resources, rather than ownership of resources (Walters 2004) to an outwards, customer focused approach. Managers need to 'adopt an entirely different approach to strategic planning and management which can enable them to deploy an extensive infrastructure network based on shared resources with other firms' (Tetteh & Burn 2001, p. 171). This requires strategic thinking, trust and a realisation of the importance of co-opting or collaboration rather than competition which typically exists amongst individual firms within an industry sector (Rowe & Pease 2005). These qualities, plus an increased confidence in the use of information systems to underpin business strategies, particularly in the SME's need to be developed in the industry.

The traditional use of information technology is that of cost reduction, collaboration is a value added approach. In an approach focusing on business-to-business colloboration information technology acts as an enabler for a new business model where management leverages all its assets including its intangible assets of partnerships (Walters 2004). Levy, Loebbecke & Powell (2001) describe cooperation and cross institutional

information flows as providing added value,, however the proposed semantic web approach lowers but does not remove the technological requirement of this approach. This indicates that support must be provided to SME's to improve their technology capacity. .

Another management implication of the use of semantic technologies is the need for management to allow time for the evolution of an ontology which represents the domain rather than a single organisation. The development of a representative ontology lowers the level of ontological commitment from any group of organisations encouraging information sharing.

The ontology may also be used in the web-based EDI paradigm, providing a common set of data elements to which an organisation may map. The provision of a domain specific ontology for the Australian timber and wood product industry plays a role in demystifying and simplifying EDI. The domain ontology therefore provides the means to bring the advantages of EDI to SMEs, while lowering the traditional barriers of technical complexity and high implementation and maintenance costs.

5.4 Further research

This is the first stage in the development of an open standard domain specific ontology for the Australian timber and wood product industry. The ontology makes an open world assumption so that it grows and gains depth with interaction and input from other domain members. The development of an

ontology gives the industry a number of options. The ontology provides a path for the industry to be part of the semantic web movement, both now and in the future, with the ontology's extensible ability allowing the ontology to evolve to reflect current needs.

The ontology has been taken as far as possible within the framework of this research. For further development, there must be a collaborative effort made by the industry to reach consensus by industry partners on an acceptable standard.

Bibliography

AgXML L.L.C. 2001, *AgXML version 1.0.0*, AgXML L.L.C., viewed 12 May 2004 2004, <http://www.agxml.org/Standard.html>.

Akkermans, H 2001, 'Emergent Supply Networks: System Dynamics Simulation of Adaptive Supply Agents', paper presented to 34th Annual Hawaii International Conference on System Sciences (HICSS-34)-, Hawaii.

Angeles, R 2000, 'Revisiting the role of Internet-EDI in the current electronic commerce scene', *Logistics Information Management*, vol. 13, no. 1, pp. 45-57.

APEC Centre for Technology Exchange and Training for Small to Medium Enterprises n.d., *SME profile - Australia*, viewed 23 April 2006 <http://www.actetsme.org/aust/aus98.html>.

Australian Bureau of Agricultural and Resource Economics 2003, *Australian forest and wood product statistics*, viewed 10 May 2004 <http://www.abareconomics.com/research/forestry/forestry.htm>.

Australian Bureau of Statistics 2005a, *National Regional Statistics*, viewed 25 January 2006 <http://www.ausstats.abs.gov.au/ausstats/2001maps.nsf/Homepages/Ausstats+NRPs>.

---- 2005b, *8129.0 Business use of information technology 2003-04*, Commonwealth of Australia, Belconnen.

Australian Government Department of Agriculture Fisheries and Forestry 2003, *About Australia's forest industry*, viewed 10 May 2004 <http://www.dpie.gov.au/content/output.cfm?ObjectID=482AB6CF-3A24-4AF9-80DA26FCC01C46FB>.

Awad, E 2002, *Electronic commerce, from vision to fulfillment*, Prentice Hall, New Jersey.

Ayers, J 2001, *Supply chain myths and realities*, viewed 14 April 2004 <http://www.itknowledgebase.net/ejourna>.

Ball, MO, Ma, M, Raschid, L & Zhao, Z 2002, *Supply chain infrastructures: System integration and information sharing*, viewed 12 May 2004 vol. 31.

Barratt, M 2004, 'Understanding the meaning of collaboration in the supply chain', *Supply Chain Management; An International Journal*, vol. 9, no. 1, pp. 30-42.

Benatallah, B, Rabhi, FA & Mehandjiev, N 2003, *E-commerce enabling technologies*, 3rd edn, Pearson Education Australia, Australia.

Berners-Lee, T, Cailliau, R, Luotonen, A, Nielsen, HF & Secret, A 1994, *The world-wide web*, viewed 12 May 2004 vol. 37.

Blake, J & Pease, W 2005a, 'An open standard for the exchange of information in the Australian timber sector', paper presented to International Telecommunications Society Africa-Asia-Australasia Regional Conference, Perth, Western Australia.

---- 2005b, 'The e-readiness of the Australian timber and wood sector', paper presented to International Telecommunications Society Africa-Asia-Australasia Regional Conference, Perth, Western Australia.

Brown, E 2002, *Accelerating the uptake of e-commerce by small and medium enterprises*, Small Enterprise Telecommunications Centre (SETEL).

Bruce, M, Daly, L & Towers, N 2004, 'Lean or agile: A solution for supply chain management in the textiles and clothing industry?' *International Journal of Operations & Production Management*, vol. 24, no. 2, pp. 151-70.

Burgess, S 2003, *A definition for small business?*, Information Resources Management Association, Special Research Cluster on Small Business and Information Technology, viewed 23 April 2006 <http://www.businessandlaw.vu.edu.au/sbirit/IRMA%20SRC%20-%20Small%20Bus%20and%20IT%20%20Research%20Issue%201%20-%20What%20is%20Small.doc>.

Burt, DN & Starling, SL 2002, 'World class supply management', paper presented to ISM 87th Annual International Supply Management Conference, San Francisco.

Cano, CR, Boles, JS & Bean, CJ 2005, 'Communication media preferences in business-to-business transactions: An examination of the purchase process', *Journal of Personal Selling & Sales Management*, vol. 25, no. 3, pp. 283-94.

Carvin, A 2004, *Tim Berners-Lee: weaving a semantic web*, viewed 24 February 2005 <http://www.digitaldivide.net/articles/view.php?ArticleID=20>.

Chaffey, D 2002, *E-business and e-commerce management*, Prentice Hall, England.

Childerhouse, P & Towill, D 2000, 'Engineering supply chains to match customer requirements', *Logistics Information Management*, vol. 13, no. 6, pp. 337-46.

Childerhouse, P, Hermiz, R, Mason-Jones, R, Popp, A & Towill, DR 2003, 'Information flow in automotive supply chains - identifying and learning to overcome barriers to change', *Industrial Management & Data Systems*, vol. 103, no. 7, pp. 491-502.

Christiaanse, E & Markus, ML 2003, ' Participation in Collaboration Electronic Marketplaces', paper presented to 36th Annual Hawaii International Conference on System Sciences
January 06 - 09, 2003, Big Island, Hawaii.

Christopher, M & Towill, DR 2000, 'Supply chain migration from lean and functional to agile and customised', *Supply Chain Management*, vol. 5, no. 4, pp. 206-13.

Colomb, R 2005, *Ontology and the semantic web study book*, vol. 1, University of Queensland, Brisbane.

Daft, RL & Lengel, RH 1986, 'Organisational information requirements, media richness and structural design', *Management Science*, vol. 32, no. 5, pp. 554-71.

DCMI 2005, *DCMI metadata terms*, viewed 16 October 2005 <http://dublincore.org/documents/dcmi-terms/>.

Decker, S, Melnik, S, Harmelen, FV, Fensel, D, Klein, M, Broekstra, J, Erdmann, M & Horrocks, I 2000, 'The semantic web: The roles of XML and RDF', *IEEE Internet Computing*, vol. 4, no. 5, pp. 63-74.

Degen, W, Heller, B, Herre, H & Smith, B 2001, *GOL: toward an axiomatized upper-level ontology*, viewed 16 October 2005 <http://www.ontology.uni-leipzig.de/Publications/Paper-FOIS-Herre-2001.pdf>.

Department of Agriculture Fisheries and Forest 1997, *Plantations for Australia - 2020 Vision*, viewed 12 May 2004 <http://www.affa.gov.au/content/output.cfm?ObjectID=D2C48F86-BA1A-11A1-A2200060B0A03314>.

Dow, C 2001, *XML: A common data exchange language for business*, viewed 29 December 2003 <http://www.itknowledgebase.net/eJournals>.

Downing, C 2002, *Performance of traditional and web-based EDI*, viewed 29 December 2003 <http://www.itknowledgebase.net/eJournals>.

EAN Australia 2004, *The EAN UCC System: The global language of business*, viewed 17 december 2004 <<http://www.ean.com.au/media/files/info/brochures/eanucc_system_brochure_v3.pdf>.>.

EAN Australia Ltd 2002, *The Australian Hardware Industry Guidelines for the Numbering and Bar Coding of Trade Items v2.0*, viewed 29 December 2003 <http://www.tradegate.org.au/>.

ebXML.org n.d., *About ebXML*, viewed 17 December 2004 <<http://www.ebxml.org/geninfo.htm>.>.

Economist Intelligence Unit 2004, *The 2004 e-readiness rankings*, viewed 29 April 2004 <http://ejournals.ebsco.com.ezproxy.usq.edu.au/Journal2.asp?JournalID=108021>.

Fawcett, SE & Magnan, GM 2002, 'The rhetoric and reality of supply chain integration', *International Journal of Physical Distribution & Logistics Management*, vol. 32, no. 5, pp. 339-61.

Fensel, D, Harmelen, FV, Horrocks, I, McGuinness, DL & Patel-Schneider, PF 2001, ' OIL: an ontology infrastructure for the Semantic Web', *IEEE Intelligent Systems*, vol. 16, no. 2, pp. 38-45.

Fensel, D, Omelayenko, B, Ding, Y, Klein, M, Flett, A, Schulten, E, Botquin, G, Brown, M & Dabiri, G 2002, *Intelligent information integration in B2B electronic commerce*, Kluwer Academic Publishers, United States of America.

Fensel, D, Staab, S, Studer, R & van Harmelen, F 2003, *Peer-to-peer enabled semantic web for knowledge management*, viewed 14 March 2006<http://www.aifb.unikarlsruhe.de/WBS/sst/Research/Publications/otk-bookv6.pdf>.

Fillis, I, Johannson, U & Wagner, B 2004, ' Factors impacting on e-business adoption and development in the smaller firm', *International Journal of Entrepreneurial Behaviour & Research*, vol. 10, no. 3.

Fisher, ML 1997, 'What Is the Right Supply Chain for Your Product?' *Harvard Business Review*, vol. 75, no. 2, pp. 105-16.

Fliedner, G 2003, 'CPFR: an emerging supply chain tool', *Industrial Management & Data Systems*, vol. 103, no. 1, pp. 14-21.

Forest and Forest Products Employment Skills Company Limited 2003, *Forest and wood products industry workforce and industry data collection survey report 2002-2003*, viewed 10 November 2004 <http://www.fafpesc.com.au/f_Final%20Report_full%20copy.pdf>.

Fu, S, Chung, J-Y, Dietrich, W, Gottemukkala, V, Cohen, M & Chen, S 1999, *A practical approach to web-based Internet EDI*, viewed 06 January 2006 <http://www.research.ibm.com/iac/papers/icdcsws99.pdf>.

Gangemi, A, Guarino, N, Masolo, C, Oltramari, A & Schneider, L 2002, 'Sweetening ontologies with DOLCE', paper presented to 13th International Conference on Knowledge Engineering and Knowledge Management (EKAW02), Spain.

Gardner, J 2005, *Factor analysis and principal component analysis: concepts, application and interpretation*, ACSPRI Winter Program 2005, Brisbane.

Goldfarb, CF & Prescod, P 2004, *XML Handbook*, 5th edn, Prentice Hall PTR, United States of America.

Golicic, SL, Davis, DF, McCarthy, TM & Mentzer, JT 2002, 'The impact of e-commerce on supply chain relationships', *International Journal of Physical Distribution & Logistics Management*, vol. 32, no. 10, pp. 851-71.

Gruber, TR 1993a, *A Translation Approach to Portable Ontology Specifications*, viewed 26 October 2004 <http://ksl-web.stanford.edu/KSL_Abstracts/KSL-92-71.html>.

---- (ed.) 1993b, *Toward principles for the design of ontologies used for knowledge sharing*, In Formal Ontology in Conceptual Analysis and Knowledge Representation, Kluwer Academic Publishers, Palo Alto.

Hardware Industry Work Group 2004, *HIWG - General information*, viewed 21 December 2004 <http://www.hiwg.org.au/documents/HIWG%20info%20pack%20-%2015%20July%202004.pdf>

Hasselbring, W & Welgand, H 2001, *Languages for electronic business communication: state of the art, Industrial management and data systems*, viewed 6 April 2004 vol. 101, <http://www.itknowledgebase.net/eJournals>.

Hayashi, K & Mizoguchi, R 2003, *Document exchange model for augmenting added value of B2B collaboration*, ACM International Conference Proceeding Series.

Hofreiter, B, Huemer, C & Klas, W 2002, 'ebXML: Status, Research Issues, and Obstacles', paper presented to 12th International Workshop on Research Issues in Data Engineering: Engineering E-Commerce/E-Business Systems, San Jose, California.

Hoyt, J & Huq, F 2000, 'From arms-length to collaborative relationships in the supply chain<SBT>An evolutionary process</sbt>', *International Journal of Physical Distribution & Logistics Management*, vol. 30, no. 9, pp. 750-64.

Huberman, AM & Miles, MB 1994, 'Data management and analysis methods', in NK Denzin & YS Lincoln (eds), *Handbook of qualitative research*, Sage Publications, Thousand Oaks.

Ireland, R & Bruce, R 2000, 'CPFR: Only the beginning of collaboration', *Supply Chain Management Review*, vol. 4, no. 4, pp. 80-7.

Jamieson, S 2004, 'Likert scales: how to (ab)use them', *Medical Education*, vol. 38, no. 12, pp. 1217-8.

Jocumsen, G 2004, 'How do small business managers make strategic marketing decisions?' *European Journal of Marketing*, vol. 38, no. 5/6, pp. 659-75.

Jun, M & Cai, S 2003, 'Key obstacles to EDI success: from the US small manufacturing companies' perspective', *Industrial Management & Data Systems*, vol. 103, no. 3, pp. 192-203.

Kalakota, R & Robinson, M 2001, *E-business 2.0, Roadmap for success*, Addison-Wesley, United States of America.

Kalakota, R, Stallaert, J & Whinston, AB 1996, *Implementing real-time supply chain optimization systems*, viewed 12 May 2004 <http://cism.bus.utexas.edu/jan/sc_imp.html>.

Kang, S 1998, 'Adoption of the Internet and the Information Superhighway for Electronic Commerce', paper presented to Thirty-First Annual Hawaii International Conference on System Sciences, Hawaii.

Klyne, G & Carroll, JJ 2004, *Resource Description Framework (RDF): concepts and abstract syntax, W3C Recommendation 10 February 2004*, viewed 19 May 2005 <http://www.w3.org/TR/rdf-concepts/>.

Lee, JY & Chan, KC 2003, 'Assessing the operations innovation bandwagon effect: A market perspective on returns', *Journal of Managerial Issues*, vol. 15, no. 1, pp. 97-105.

Leedy, PD & Ormrod, JE 2001, *Practical research: planning and design*, 7th edn, Pearson Prentice Hall, New Jersey.

Levy, M, Loebbecke, C & Powell, P 2001, 'SMEs, co-opetition and knowledge sharing: the role of information systems', *European Journal of Information systems*, vol. 12, no. 1, pp. 3-17.

Lu, EJ-L & Wu, C-C 2004, 'A ReScUE XML/EDI model', *Software: Practice and Experience*, vol. 34, no. 3, pp. 315-38.

Luster, S, Yee, T, Crawford, M, Parker, R, Andonyadis, C & Drake, D 2000, *Open buying on the Internet and extensible markup language recommendations on adoption by the Federal Government*, viewed 16 December 2004 <http://www.smartcard.gov/information/OpenBuyingXML.pdf>.

MacCallum, R 1998, 'Commentary on quantitative methods in IO research', *The Industrial Organizational Psychologist*, vol. 35, pp. 19-30.

Magretta, J 1998, 'Fast, global, and entrepreneurial: supply chain management, Hong Kong Style: an interview with Victor Fung', *Harvard Business Review*, vol. September-October, pp. 103-14.

Maritime e-commerce association 2002, *Standards/ e-procurement*, viewed 17 April 04 <www.meca.org.uk/standards.asp?standardsID=4>.

Mason-Jones, R & Towill, DR 1997, 'Information enrichment: designing the supply chain for competitive advantage', *Supply Chain Management*, vol. 2, no. 4, pp. 137-48.

---- 1998, 'Time compression in the supply chain: information management is the vital ingredient', *Logistics Information Management*, vol. 11, no. 2, pp. 93-104.

McComb, D 2005, *The CIO's guide to semantics, version 2*, Semantic Arts, Incorporated.

McGuinness, DL & van Harmelen, F 2004, *OWL Web Ontology Language overview W3C recommendation 10 February 2004*, viewed 20 December 2005 <http://www.w3.org/TR/owl-features/>.

Meegoda, R 2003, 'An e-business standard for the timber industry, proposal for a work item', Hyne & Son Proprietary Limited document.

Microsoft Corporation 2003, *Understanding XML*, viewed 17 April 2004 <http://msdn.microsoft.com/webservices/understanding/xmlfundamentals/default.aspx?pull=/library/en-us/dnxml/html/understxml.asp>.

Moozakis, C 2001, 'Jupiter: EDI Is Here To Stay', *InternetWeek*, no. 849, p. 12.

Mulligan, RM 1998, 'EDI in foreign trade: Case studies in utilisation', *International Journal of Physical Distribution & Logistics Management*, vol. 28, no. 9, pp. 794-804.

Mullins, R, Duan, Y & Hamblin, D 2001, 'A pan-European survey leading to the development of WITS', *Internet Research: Electronic Networking Applications and Policy*, vol. 11, no. 4, pp. 333-40.

Neuman, W 2003, *Social research methods, qualitative and quantitative approaches*, 5th edn, Allyn and Bacon, Boston.

Nurmilaakso, J-M, Kettunen, J & Seilonen, I 2002, 'XML-based supply chain integration: a case study', *Integrated Manufacturing Systems*, vol. 13, no. 8, pp. 586-95.

Organisation for Economic Co-operation and Development 2005, *OECD Broadband Statistics, December 2004*, viewed 15 March 2006 < <http://www.oecd.org/document/60/0,2340,en_2649_34225_2496764_1_1_1_1,00.html>.

Parker, CM & Swatman, PMC 1996, 'TREAT: Promoting SME adoption of EDI through education', paper presented to 29th Hawaii International Conferences on System Sciences (HICSS 29), Hawaii, January 03-06.

Patil, S & Newcomer, E 2003, 'ebXML and web services', *IEEE Internet Computing*, vol. 7, no. 3, pp. 74-82.

Pease, W 2001, *E-commerce enabling technologies*, viewed 01 June 2004 <http://www.usq.edu.au/users/pease/publications/Ecommerce%20Enabling%20Technologies.pdf>.

Pease, W & Rowe, M 2002, *E-commerce and small and medium enterprises (SMEs) in regional communities*, viewed 8 March 2006 <http://www.usq.edu.au/users/pease/publications/Ecommerce%20and%20SMEs.pdf>.

---- 2003, 'Issues Faced by Small and Medium Enterprises (SMEs) and Their Take-Up of Ecommerce in Australian Regional Communities', paper presented to 4th International We-B Conference 2003 (We-B03), Perth, Australia, November 24-25.

Peng, L, He, K, Li, B & Liu, J 2004, 'Interoperability Test of ebXML e-Business Solutions', paper presented to The Fourth International Conference on Computer and Information Technology, Wuhan, China.

Popp, A 2000, 'Swamped in information but starved of data: information and intermediaries in clothing supply chains', *Supply Chain Management; An International Journal*, vol. 5, no. 3, pp. 151-61.

Power, DJ & Sohal, AS 2002, 'Implementation and usage of electronic commerce in managing the supply chain: A comparative study of ten Australian companies', *Benchmarking: An International Journal*, vol. 9, no. 2, pp. 190-208.

Prem PremKumar, G 2000, *Interorganization systems and supply chain management, an information processing perspective*, viewed 26 December 2003 vol. Summer 2000, <http://www.itknowledgebase.net/ejournal>.

---- 2003, *Perspectives of the e-marketplace by multiple stakeholders*, Communications of the ACM, vol. 46, <http://delivery.acm.org/10.1145/960000/953512/p279-premkamar.pdf?key1=953512&key2=7012998801&coll=ACM&dl=ACM&CFID=23698926&CFTOKEN=9628477>.

Rahman, Z 2004, *Use of Internet in supply chain management: a study of Indian companies*, viewed 30 January 2004 vol. 104, <http://www.emeraldinsight.com.ezproxy.usq.edu.au/Insight/ViewContentServlet?Filename=/published/emeraldfulltextarticle/pdf/0291040103.pdf>.

Ratnasingam, P 2002, 'The importance of technology trust in Web services security', *Information Management & Computer Security*, vol. 10, no. 5, pp. 255-60.

Reimers, K 2001, 'Standardizing the new e-business platform: learning from the EDI experience', *Electronic Markets*, vol. 11, no. 4, pp. 231-7.

Ritter, D 2000, 'XML: The missing link for B2B e-commerce', *Intelligent Enterprise magazine*, vol. 2, no. 7.

Rogers, E 1995, *Diffusion of innovations*, 4th edn, Free Press, New York.

Roman, D, Keller, U, Lausen, H, Bruijn, Jd, Lara, R, Stollberg, M, Polleres, A, Feier, C, Bussler, C & Fensel, D 2005, 'Web Service Modeling Ontology', *Applied Ontology*, vol. 1, no. 1, pp. 77-106.

Rosemann, M & Green, P 2000, 'Integrating multi-perspective views into ontological analysis', paper presented to twenty first international conference on Information systems, Brisbane, Queensland, Australia.

RosettaNet 2004, *Frequently Asked Questions about RosettaNet*, viewed 16 december 2004 <<http://www.rosettanet.org/RosettaNet/Rooms/DisplayPages/LayoutInitial?Container=com.webridge.entity.Entity%5BOID%5B22107C9E15B9684D94D836A18BB2CE80%5D%5D>.>.

Rowe, M & Pease, W 2005, 'Use of Information Technology to facilitate collaboration and co-opetition between tourist operators in tourist destinations', paper presented to Tourism Enterprise Strategies: Thriving - and Surviving - in an Online Era, Melbourne, Australia, 11-12 July.

Sahay, BS 2003, *Understanding trust in supply chain relationships*, viewed 11 May 2004 vol. 103.

Sánchez, AM & Pérez, MP 2003, 'The use of EDI for interorganisational co-operation and co-ordination in the supply chain', *Integrated Manufacturing Systems*, vol. 14, no. 8, pp. 642-51.

Satzinger, JW, Jackson, RB & Burd, SD 2000, *Systems analysis and design in a changing world*, Course Technology, United States of America.

Schneider, G 2003, *Electronic commerce*, Thomson course technology, Canada.

Schoop, M, Becks, A, Quix, C, Burwick, T, Engels, C & Jarke, M 2002, 'Enhancing decision and negotiation support in enterprise networks through semantic web technologies', paper presented to XML Technologien für das Semantic Web - XSW 2002, Proceedings zum Workshop.

Schurr, PH & Ozanne, JL 1985, *Influences on exchange processes: buyer's preconceptions of a seller's trustworthiness and bargaining toughness*, viewed 11 May 2004 vol. 11.

Scupola, A 2002, 'Adoption issues of business-to-business internet commerce in European SMEs', paper presented to 35th Hawaii International Conferences on System Sciences (HICSS 35), Hawaii, January 7 - 10.

Senn, JA 1998, 'Expanding the reach of electronic commerce, the Internet EDI alternative', *Information Systems Management*, vol. 15, no. 3, pp. 1-9.

Shim, S, Pendyala, V, Sundaram, M & Gao, J 2000, 'Business-to-business e-commerce frameworks', *IEEE Computer*, vol. 33, no. 10, pp. 40-7.

Simatupang, TM, Wright, AC & Sridharan, R 2004, 'Applying the theory of constraints to supply chain collaboration', *Supply Chain Management*, vol. 9, no. 1, pp. 57-70.

Simchi-Levi, D, Kaminsky, P & Simchi-Levi, E 2003, *Designing and managing the supply chain*, 2nd edn, McGraw-Hill, New York.

Singh, J 1996, 'The importance of information flow within the supply chain', *Logistics Information Management*, vol. 9, no. 4, pp. 28-30.

Siorpaes, K 2004, *On Tour: System design*, viewed 17 October 2005 <http://e-tourism.deri.at/ont/docu2004/OnTour%20-%20System%20Design.pdf>.

Small enterprise telecommunications centre limited 2001, *The other digital divide: E-commerce and Australian small business*, viewed 7 March 2006 <http://www.setel.com.au/site.php?id=79>.

Spekman, RE, Kamauff, JW, Jr. & Myhr, N 1998, 'An empirical investigation into supply chain management: A perspective on partnerships', *International Journal of Physical Distribution & Logistics Management*, vol. 28, no. 8, pp. 630-50.

Stalk, G & Hout, TM 1990, *Competing against time: how time based competition is reshaping global markets*, The Free Press, New York.

Standards Australia International Ltd 2003, *Welcome message from BizDex*, viewed 15 February 2005 <http://www.bizdex.com.au/>.

Stanford Medical Informatics 2005, *Welcome to Protégé*, viewed 17 October 2005 <http://protege.stanford.edu/index.html>.

Strader, TJ, Lin, FR & Shaw, MJ 1999, *Business-to-business electronic commerce and convergent assembly supply chain management*, viewed 11 May 2004 vol. 14.

Tetteh, E & Burn, J 2001, 'Global strategies for SMe-business: Applying the SMALL framework', *Logistics Information Management*, vol. 14, no. 1, pp. 171-80.

Tom, A 2002, *Identification of timber with the EAN/UCC numbering standard: Product variability considerations, version 1.0*, <http://www.hiwg.org.au/tieg/documents/HIWG%20Identification%20of%20Timber%20V1.0%20FINAL.pdf>.

---- 2003, *The implementation of fixed and variable measure GTINs for set length packs: version 1.0*, viewed 20 December 2004 <http://www.hiwg.org.au/tieg/documents/TIEG%20RP%20Generic%20GTIN%20Dec%202003.pdf>.

Towill, DR 1997, 'The seamless supply chain - the predator's strategic advantage', *International Journal of Technology Management*, vol. vol. 13, no. 11 May 2004, pp. pp. 37-56.

Trastour, D, Bartolini, C & Preist, C 2002, 'Semantic Web Support for the Business-to-Business e-commerce lifecycle', paper presented to Proceedings of the eleventh international conference on World Wide Web, Honolulu, Hawaii, USA.

Turban, E, King, D, Lee, J & Viehland, D 2004, *Electronic commerce 2004*, Pearson Prentice Hall, New Jersey.

University of Bath n.d., *Definitions,* viewed 26 April 2006-04-26 < http://www.bath.ac.uk/~masjap/EuLisp/terms.html>

Updegrove, A 2005, *The semantic web: An interview with Tim Berners-Lee*, viewed 19 October 2005 <http://www.consortiuminfo.org/bulletins/semanticweb.php>.

Wadsworth, Y 1998, *What is participatory action research?*, viewed 05 June 2004 <http://www.scu.edu.au/schools/gcm/ar/ari/p-ywadsworth98.html>.

Walker, M 1994, 'Supplier-Retailer Collaboration in European Grocery Distribution', *Logistics Information Management*, vol. 7, no. 6, pp. 23-7.

Walters, D 2004, 'New economy -- new business models -- new approaches', *International Journal of Physical Distribution & Logistics Management*, vol. 34, no. 3/4, pp. 219-29.

Ward, J & Peppard, J 2002, *Strategic planning for information systems*, 3 edn, John Wiley & Sons, Ltd, Chichester.

Wilde, C 1997, 'New life for EDI? The Internet may help electronic data interchange finally meet expectations', *InformationWeek*, vol. March 17.

Williams, AB, Krygowski, TA & Thomas, G 2002, 'Using Agents to Reach an Ontology Consensus', paper presented to International Conference on Autonomous Agents, Bologna, Italy.

Wilson, M & Deans, KR 2000, *E-business and SMEs in the Otago region of New Zealand*, Southern Cross University, viewed 7 March 2006 <http://ausweb.scu.edu.au/aw01/papers/refereed/deans/paper.html>.

Witte, CL, Grunhagen, M & Clarke, RL 2003, *The integration of EDI and the Internet*, viewed 26 December 2003 vol. Fall 2003, <http://www.itknowledgebase.net/ejournal>.

Wong, A 1999, 'Partnering through cooperative goals in supply chain relationships', *Total Quality Management*, vol. 10, no. 4/5, pp. 786-93.

Yen, BP-C & Ng, EOS 2003, 'The migration of electronic commerce (EC): from planning to assessing the impact of EC on supply chain', *Management Decision*, vol. 41, no. 7, pp. 656-65.

Zikmund, WG 2003, *Business research methods*, 7th edn, Thomson South-Western, United States of America.

List of Tables

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Glossary

ANSI X.12 (American National Standards Institute): The subset of EDI standards developed, approved, and maintained by the ASC X12 Committee. < www.sapgenie.com/sapedi/glossary.htm >

IT governance: how the authority for resources, risk, conflict, resolution and responsibility is shared among business partners. (Ward & Peppard 2002, p. 46)

Ontology: An ontology is a formal, explicit specification of a shared conceptualization. 'Conceptualization' refers to an abstract simplified model of the real world. 'Explicit' means that the type of concepts used, and the constraints on their use are explicitly defined. 'Formal' refers to the fact that the ontology should be machine readable. 'Shared' reflects that ontology should capture consensual knowledge accepted by the communities (Gruber 1993).

UN/EDIFACT (United Nations Electronic Data Interchange for Administration, Commerce, and Trade): The name of the standard developed by the United Nations for cross-industry electronic interchange of business transactions. While transactions in North America generally use the X12 standard, UN/EDIFACT is the predominant EDI standard in the rest of the world. < www.dep.state.pa.us/dep/deputate/oit/ec/information/plans/def/ecgl.htm >

LAN (Local Area Network): A network located in a small geographic area, such as an office, building or complex of buildings (Fitzgerald & Dennis 2002)

MAN (Metropolitan Area Network): A network that usually covers a citywide area (Fitzgerald & Dennis 2002).

WAN (Wide Area Network): A network spanning a wide geographical area. (Fitzgerald & Dennis 2002).

Appendix A

Date

Dear Respondent

The enclosed survey is being sent to organisations in the Australian Timber Industry and aims to gather information on business-to-business communication, for example what type of technology is used and what issues are being faced by the Timber Industry. Building strong communication links between trading partners has been found to be a strong tool in reducing supply chain costs.

The questionnaire should be filled in by the person responsible for communicating with other organisations, for example ordering goods or receiving purchase orders, or by the person in change of the organisation's information systems.

This study is supported by the Forest and Wood Product Research and Development Corporation (Project Number PG04.5017) and the University of Southern Queensland. The questionnaire has been designed to be completed in 5 - 10 minutes and it will be of great importance to this project to receive your input. Confidentiality of your response is a priority and all data gained will be stored in a summarised form with no links to the survey document.

The results of this survey will be summarised in a report and sent to all interested participants. Please register your interest in receiving this report by filling in the tear off sheet on the back of the questionnaire.

I would be happy to answer any questions you may have and can be contacted on 0X-XXXX XXXX.

Thank you for your assistance and time.

Yours sincerely

Jacqueline Blake

Business-to-business communication and Information Systems

Q1 Please indicate your job title.

……

Q2 Please describe in a few words your role in the organisation

……

Q3 Which of the following sectors would best describe your organisation (Please tick all those that apply) – See Glossary for definitions of each category.

- ☐ Forest growing and management
- ☐ Harvesting and Haulage
- ☐ Sawmilling and processing
- ☐ Timber products manufacturing
- ☐ Wood panel/ Board production and manufacturing
- ☐ Pulp and Paper manufacturing
- ☐ Timber merchandising

Q4 How many full time employees do you have?

- ☐ 1-4
- ☐ 5-19
- ☐ 20-99
- ☐ 100-199
- ☐ 200 or more

Q5 Please indicate the number of business location(s) your business operates in each state.

State	**Number of branches**
Tasmania	
Victoria	
New South Wales	
Australian Capital Territory	
Queensland	
Western Australia	
Northern Territory	
South Australia	
Other (Please specify)	

……

Q6 Please indicate which states your organisation sells products to.

- ☐ Tasmania
- ☐ Victoria
- ☐ New South Wales
- ☐ Australian Capital Territory
- ☐ Queensland
- ☐ Western Australia
- ☐ Northern Territory
- ☐ South Australia
- ☐ Export (Please list countries or regions you export to)

……
……

Q7 Please choose a definition of **business-to-business** communication that reflects how your organisation defines its communication with other businesses.

- ☐ To deliver information, products/services and payments over the telephone, communication networks or other means.
- ☐ Any communication between two parties who are commercial in concept.
- ☐ Access to information across geographic, organizational, and technology barriers.
- ☐ Any business communication between two companies that uses digital technology.
- ☐ Other (a definition that better reflects your organisation)

……..
……..

Q8 Does your business have internet access?

- ☐ Yes – Please go to **Q 9**
- ☐ No – Please go to **Q10**

Q9 If yes is your internet access by

- ☐ Dial up modem
- ☐ ADSL Broadband
- ☐ Cable
- ☐ ISDN
- ☐ LAN, WAN or MAN
- ☐ Other ……

Q10 Please describe your information technology configuration

- ☐ No computers used
- ☐ Stand alone desktop computer(s)
- ☐ Networked desktop computers that share data (peer-to-peer)
- ☐ Networked desktop computers that share data (Local Area Network LAN)
- ☐ Distributed system consisting of local area networks, connected into Metropolitan Area Network (MAN) or Wide Area Network (WAN).
- ☐ Large scale centralised mainframe system
- ☐ Other (please describe)

……
……

Q11 Below is a list of statements describing how your organisation communicates with **other branches** of your organisation. Please indicate how often your organisation uses each method by circling the number which best represents your answer.

☐ Our organisation does not have any other branches, please move to next question.

Statement	Never	Rarely	Sometimes	Frequently	Constantly
The postal service.	1	2	3	4	5
Fax	1	2	3	4	5
Telephone	1	2	3	4	5
Dial up modem	1	2	3	4	5
Broadband	1	2	3	4	5
Intranet	1	2	3	4	5
Satellite Link	1	2	3	4	5
Leased line data service	1	2	3	4	5
Other (please describe below)	1	2	3	4	5

Please describe any other technologies that you are using to communicate between company branches.

……
……

Q12 Below is a list of statements describing how your organisation communicates with **other businesses**. Please indicate how often your organisation uses each method by circling the number which best represents your answer.

Statement	Never	Rarely	Sometimes	Frequently	Constantly
The postal service.	1	2	3	4	5
Fax	1	2	3	4	5
Telephone	1	2	3	4	5
email	1	2	3	4	5
An extranet	1	2	3	4	5
Electronic Data Interchange (EDI)	1	2	3	4	5
Other (please describe below)	1	2	3	4	5

Please describe any other technologies that you are using to communicate **other businesses**.

……

……

Q13 Below is a list of statements about how your organisation views information technology. Please indicate whether you agree or disagree with each statement, by *circling* the number that best represents your answer.

Statement	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
Does your organisation consider themselves to be technically innovative?	1	2	3	4	5
Does your organisation regularly consider adopting new methods of communication?	1	2	3	4	5
My organisation would be more effective if we developed better relationships with our trading partners	1	2	3	4	5
My organisation would be more effective if the information flows between it and our trading partners were integrated.	1	2	3	4	5
My organisation uses the most effective means to communicate with our trading partners.	1	2	3	4	5
My organisation uses information technology to gain competitive advantage in the marketplace.	1	2	3	4	5
Recruiting and developing information systems staff is difficult for our organisation.	1	2	3	4	5
In my organisation money spent on information technology is considered money well spent.	1	2	3	4	5

Are there any comments you would like to make about your answers in the above question?

……

……

……

Q14 What are the business issues that your organisation is facing now?

……

……

……

Q15 What are the business issues that your organisation believes will be important **in the future** (5 years)?

……
……
……

Q16 Below is a list of statements about issues in business-to-business communication now and in the future. Please indicate whether you agree or disagree with each statement, by *circling* the number that best represents your answer. The first row is how your organisation feels about the issue **now,** while the second row is how your organisation feels about the issue in the **future** (5 years time**)**.

Statement	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly agree*	*Don't Know*
Security of data while it is being transmitted is important in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
The security of our stored data is a priority in our organisation.						
Now	1	2	3	4	5	6
	1	2	3	4	5	6
The authentication of the sender of a message is an important issue in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
The volume of email received is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Control of spam is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
That the originator of an electronic message cannot deny authorship at a later date (Nonrepudiation) is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
The integrity of our data is a priority for our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Complying with privacy regulations is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Complying with changing communication standards is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Meeting trading partner's technical requirements is a burden for our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Maintaining the availability of our communication service is a priority in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
The required bandwidth for communication is readily available.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
The cost of providing the required bandwidth for communication is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Statement	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly agree*	*Don't Know*

Statement	*Strongly disagree*	*Disagree*	*Neutral*	*Agree*	*Strongly agree*	*Don't Know*
Maintaining protection against malicious software (viruses, worms, Trojan horses etc) is a priority for our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Gaining industry agreement for a standard used to describe products is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Gaining industry agreement on communication standards is a concern in our organisation.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Lack of interoperability (ability of different types of computers, networks, operating systems and applications to work together effectively) is an issue for our organisation's information system.						
Now	1	2	3	4	5	6
In the future	1	2	3	4	5	6
Other (please detail below)						

Other issues that your organisation believes are important in business-to-business communication **now**.

……
……
……

Other issues that your organisation believes are important in business-to-business communication **in the future** (5 years).

……
……
……

Q17 What is a brief description of your organisation's primary means of communicating with your customers?

……
……
……

Q18 What is a brief description of how your organisation would place an order with a major supplier?

……
……
……

Q19 Does your organisation use Supply Chain Management (SCM)?

- ☐ Yes
- ☐ No
- ☐ Don't know

Q20 Electronic Data Interchange (EDI) is a set of standardized electronic business documents, which are exchanged in agreed upon formats, between businesses. Does your organisation use EDI?

- ☐ Yes – Please go to **Q24**
- ☐ No – Please go to **Q21**
- ☐ Don't know - Please go to **Q28**

Q21 Would your organisation consider using EDI?

- ☐ Yes - Please go to **Q22**
- ☐ No - Please go to **Q28**
- ☐ Don't know - Please go to **Q22**

Q22 Would your organisation consider using EDI if:
Please check all those that apply.

- ☐ More trading partners wished to use EDI.
- ☐ EDI standards were easier to implement.
- ☐ EDI maintenance costs were reduced.
- ☐ EDI software was available at a nominal cost.
- ☐ Technical implementation of EDI was simplified.
- ☐ The time frame required to recover implementation costs is reduced.
- ☐ Other – Please detail below

  ……..

Q23 Do your trading partners use EDI with other organisations?

- ☐ Yes
- ☐ No
- ☐ Don't know

Thank you, please go to **Q28**

Q24 How many trading partners do you use EDI with?

- ☐ 1-3
- ☐ 4-6
- ☐ 7-9
- ☐ 10-12
- ☐ 13-15
- ☐ 16 or more

Q25 How many different versions of EDI does your organisation use to accommodate your trading partners needs?

- ☐ 1
- ☐ 2 to 4
- ☐ 5 to 7
- ☐ 8 to 10
- ☐ More than 10

Q26 What EDI standard does your organisation currently use?

- ☐ UN/EDIFACT
- ☐ Proprietary standard (own organisations)
- ☐ Proprietary standard (other organisations)
- ☐ Other (please specify)

……

Q27 Who is the vendor and what version is your EDI product (s)

……

Q28 Does your organisation maintain an information systems strategic plan?

- ☐ Yes
- ☐ No

(If yes, it would help strengthen the results of the study, if a copy of the plan could be returned with the questionnaire. All responses to the questionnaire and strategic plans will be kept confidential)

Q29 What strategies does your organisation plan to adopt to gain the desired future business-to-business communications infrastructure?

……
……
……
……
……

Q30 Is your organisation willing to participate in a study to develop a standard set of terms to describe timber and wood products for use in business-to-business communication?

- ☐ Yes (please fill out the contact sheet attached to the questionnaire)
- ☐ No

Are there any additional comments you would like to make?

Glossary

Question 3: Industry sector terms

Forest growing and management: Growing Management and maintenance of timber resources.

Harvesting and Haulage: Covers the processes associated with harvesting timber, for example timber felling, haulage.

Sawmilling and processing: Businesses associated with the processing of logs and other forms of raw timber in timber mills, factories, merchants premises etc, for example saw mills, wood chip mills and timber treatment plants.

Timber products manufacturing: Businesses using the processes associated with machining timber to produce components and articles, for example frame and truss manufacturers, flooring and furniture manufacturers, poles and pile manufacturers.

Wood panel/ Board production and manufacturing: Businesses associated with manufacturing of boards, panels or veneer, for example MDF manufacturers, particle board enterprises and panel and veneer manufacturing businesses.

Pulp and Paper manufacturing: For example pulping and paper manufacturing enterprises, newsprint manufacturing enterprises

Timber merchandising: These businesses demonstrates, prepares, handles, provides advice and sells timber, timber-related products, hardware and building products.

Other Definitions

Bandwidth: The amount of data that can be sent from one computer to another through a particular connection in a certain amount of time. It can be thought of the width or capacity of a communications channel. The more bandwidth available, the faster you are able to access information.

Business-to-business (B2B): Transactions with non-consumer purchasers such as manufacturers, resellers (distributors, wholesalers, loggers and retailers, for example) institutional, professional and governmental organisations.

Electronic Data Interchange (EDI): Is a set of standardized electronic business documents, which are exchanged in agreed upon formats, between businesses.

ISDN (Integrated Services Digital Network): A service offered by telephone companies that allows a user to connect to a network (or internet) over standard phone lines at speeds that are faster than a dial up modem.

Leased line data service: This is a dedicated point to point, high capacity digital service which is capable of transmitting data at speeds up to 1.984 Mbps. A leased line data service offers n channels, each at 64 Kbps, allowing carriers to offer the subscriber a choice of the number of channels they need. An example of a leased line data service is Telstra's DDS Fastway service.

Contact Details

Please fill in this contact sheet if your organisation is willing to participate in a study to prepare a standard set of names for timber. This study will assist in the development of low cost non-technology intensive systems for business-to-business communication.

☐ My organisation is prepared to participate in a further study.

Please also fill out this contact sheet if your organisation wishes to receive a copy of the results of the survey

☐ Please send a report summarising the results of this questionnaire.

Name of organisation:

.....

Address:

.....

.....

.....

.....

Phone Number:.....

Fax Number:.....

Name of contact person:.....

Contact phone number:.....

Email:.....

Thank you for taking the time to complete this survey. Your co-operation is much appreciated. Please return the survey in the reply paid envelope provided.

Appendix B

Question 29:

What strategies does your organisation plan to adopt to gain the desired future business-to-business communications infrastructure?

No Plans for change

- Happy with present structure
- Maintain status quo
- No plans to present methods of operation
- Need increased growth before it becomes an issue
- Don't have any strategies and still waiting for trading partners to catch up with internet use.
- Happy with what we have
- Nil at present (food for thought)
- Continue with present contacts
- We cannot move ahead unless we relocate our work premises
- Needs investigating, unfortunately there are many issues in our industry that need attention and communication infrastructure does not get a look in at present. The division between governments has created an unhealthy environment in the day to day running.
- Common sense
- Not considered any
- Carry on as we are
- Not in the pipeline
- No plans at present
- No strategies - cannot see B2B being useful in the near future
- We at this stage quite small
- Business as usual
- Not considered
- no changes foreseeable
- No specific strategies in place
- happy with existing arrangements
- No strategies at moment
- We are too small
- Not really required by me at this point
- We email/ fax outstanding orders on an internal designed document which encourages
- our clients to re-order via email or fax
- We will continue to use the telephone.
- Continued supply of quality products, continued intrapersonal communication
- Maintain personal contact with our business partners
- We will keep it under review at this stage
- Open communication
- Assess our business needs
- Continue to investigate ways to do things better when time and money permit.

- Develop as needed
- 27 responses of None or Nil

Don’t know

- Don't know
- Not sure
- Don't know
- Don't know at present
- Not sure - At this stage, knowledge of systems too limited so maintaining status quo
- business is growing and possibly need to consider more professional help in this area
- Not quite sure
- Unsure determined by NZ

Driven by trading partners

- Continue to enquire of other businesses about their requirements
- Verbal communication with business partners to keep pace with technology and also our IT providers to do likewise.
- We will be lead by our customers
- Talk to suppliers and customers about their systems and see if we can be compatible with them.
- reaction to future needs/ shortfalls
- This would be dictated by our trading partners
- Strong relationships with customers and suppliers. In constant contact with our computer advisor

Monitor new developments

- Read any important information on new communication programmes and update
- To keep up with all new desirable and helpful technologies
- Keep up to date with technologies, trends, hardware
- Constant discussions and communication with IT and communication providers to stay abreast of technology.
- Monitor the IT news and discuss with our consultant for our database.
- Take note of changes via various sources.
- Follow business trends

Upgrade of technology planned

- Internet
- Update the computer, connect to broadband when available at a comparable price
- We are designing a computer package at the moment
- Installation of broadband when available
- We will have ADSL installed at two locations, no other plans as we see the need to improve communications
- Website upgrade
- faster connection to email

- Upgrade computer network, install document centre - direct email etc
- Upgrade software to more widely used programs and windows compatible. Improve
- office hardware to deal with technology change, work with suppliers and customers to
- develop B2B relationships.
- Applying for broadband
- continued expansion of computer technology
- Keeping up with technology
- Upgrade computer and factory, begin using PDA on site
- Interactive website and stock lists, tallies, ordering facility
- Intranet use commenced, email use to be increased, ADSL would assist immensely,
- phone control is in place and will continue.
- Centralised computing systems
- More emailing
- Migrating from a UNIX to MS windows set-up
- Considering online ordering of products by our customers. More online purchasing by our business

<u>Strategy in place</u>

- Continue of current and future implementation plans which flex with customer requirements.
- Constantly investigating new possibilities
- Put budget aside
- Working with the National Builders supplier group
- Exploring options now with various systems to achieve EDI
- We are developing our systems so that we can use EDI with our major customer base.
- Detailed IT Plans
- Under development
- Remain open to technological advancement and employ key personal to seek out opportunities that offer efficiency gains and advancement.
- Maintain effective and up to date software and gradually connect to smart thinking suppliers with their new technology.
- Our company will always have a communication framework and we are developing and have developed applications that allow us to communicate fax, email and e-commerce
- Adoption of industry standards (messaging) for scalability, scaling existing middleware.
- We support an established industry working group that is developing common specifications. We will then source required software from suppliers who offer systems compatible with industry standards and our own IT system
- Roll out of B2B with selected suppliers.
- Periodic review

- Use the technical skills of people in that business
- Tell suppliers what they have to do.
- Move away from emails and focus more on real life meetings

Appendix C

Question 13:

Are there any comments you would like to make about your answers in the above question?

Themes

That the best use of information technology to facilitate communication was not a priority.

- My business is small and there is not enough hours in the day to cost effectively research all communication options.
- These issues are well down the list of importance in our efforts to stay profitable.
- Ours is a price driven industry working with a very business negative government
- Not strong on technology.
- The above question is not of great importance to the ongoing success or governance of our business
- Do not have financial resources to spend on dedicated IT professional, so IT is given to person with best knowledge. I am not trained in IT but do best I can with it, I have greater priority in achieving sales budgets. IT is done outside normal work hours.
- A lot of money can be wasted on software that does not meet expectations. IT is about the longest priority I could think of.
- There is a lack of suitably trained, recruited or existing staff skilled in any form of computer skills. All very hands on and not computer savvy.
- I feel the internet is over-rated.
- How organisation would be much more effective if we could find people willing to work in a hands on hard work environment!! Forget the information systems staff.
- IT is provided externally, we don't employ staff as specific to IT, we have small admin team.
- Technological change not high on agenda of development.
- We're only a small business with a few established suppliers and wholesalers.

Business-to-business communication is driven by trading partners.

- Most of information transfer is with employer, who is a long way behind the 8 ball.
- which accounts for the major time factor in running a business.
- Most timber yards/ sawmills still communicate primarily by phone or fax. Therefore these are the best methods for communicating with them. Office is run from home and that means I use the technology that I feel the most comfortable with and is practical.
- We would use email more, but our suppliers and customers do not facilitate
- this.

- We are going down the e-commerce track with one of our suppliers and if that is successful we will push on and try and develop with our other suppliers.
- Our clients are builders at construction sites with only access via phone.
- Thought of EDI back in early 1990's had to wait till now because we are a small company and had to wait until rest of technology and industry woke up.
- Wish to communicate more electronically but customers not set up.

In process of upgrading

Company is making a strong move forward implementing a system based on state of the art technology.
We are looking to become technologically innovative and gain a competitive advantage.

Sundry Comments

- As a small/ medium size sawmilling business it is difficult to obtain suitable production/ accounting software to assist us in our tasks.
- Our sales average $200 each with a turnover of $1000000/ month.
- All software products off the shelf.
- We do not use computers, yet we consider ourselves to have satisfactory communication and information storage/ processing systems.
- Broadband isn't available in our region and our phone lines were antiquated 10 years ago with no hope of any kind of upgrade.

Appendix D

```
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  <owl:disjointWith>
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  </owl:disjointWith>
  <owl:disjointWith>
    <owl:Class rdf:about="#Construction"/>
  </owl:disjointWith>
</owl:Class>
<owl:Class rdf:about="#MediumDensityFibreboard">
  <rdfs:subClassOf>
    <owl:Class rdf:about="#Construction"/>
  </rdfs:subClassOf>
  <owl:disjointWith>
    <owl:Class rdf:about="#FingerJointed"/>
  </owl:disjointWith>
  <owl:disjointWith rdf:resource="#Solid"/>
</owl:Class>
<owl:Class rdf:ID="Hardwood">
  <rdfs:subClassOf rdf:resource="#Species"/>
  <owl:disjointWith>
    <owl:Class rdf:ID="Softwood"/>
  </owl:disjointWith>
```

```
  </owl:Class>
  <owl:Class rdf:ID="SI-system">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >Systeme International d'Unites: a complete metric system of units of
measurement for scientists</rdfs:comment>
  </owl:Class>
  <owl:Class rdf:about="#FingerJointed">
    <owl:disjointWith rdf:resource="#Solid"/>
    <rdfs:subClassOf>
      <owl:Class rdf:about="#Construction"/>
    </rdfs:subClassOf>
    <owl:disjointWith rdf:resource="#MediumDensityFibreboard"/>
  </owl:Class>
  <owl:Class rdf:ID="Yes">
    <rdfs:subClassOf>
      <owl:Class rdf:ID="NominalSize"/>
    </rdfs:subClassOf>
    <owl:disjointWith>
      <owl:Class rdf:ID="No"/>
    </owl:disjointWith>
  </owl:Class>
  <owl:Class rdf:about="#Construction">
    <owl:disjointWith>
      <owl:Class rdf:about="#Seasoning"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Species"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Profile"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Size"/>
    </owl:disjointWith>
    <owl:disjointWith>
      <owl:Class rdf:about="#Grade"/>
    </owl:disjointWith>
    <owl:disjointWith>
      <owl:Class rdf:about="#Dressing"/>
    </owl:disjointWith>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
  </owl:Class>
  <owl:Class rdf:about="#SetLengthPack">
    <owl:disjointWith>
      <owl:Class rdf:about="#CutToLengthPack"/>
    </owl:disjointWith>
    <rdfs:subClassOf rdf:resource="#Pack"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#RandomLengthPack"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#StandardMixedLengthPack"/>
```

```
  </owl:Class>
  <owl:Class rdf:ID="Mill"/>
  <owl:Class rdf:about="#No">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#NominalSize"/>
    </rdfs:subClassOf>
    <owl:disjointWith rdf:resource="#Yes"/>
  </owl:Class>
  <owl:Class rdf:ID="SinglePiece">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#UnitOfSale"/>
    </rdfs:subClassOf>
  </owl:Class>
  <owl:Class rdf:ID="Strength">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#Grade"/>
    </rdfs:subClassOf>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >refers to the classification of a species into strength groups, S1 to S7 for
unseasoned (green) and SD1 to SD8 for seasoned (dry). The lower the
number the greater the strength, irrespective of any faults that may be
present.</rdfs:comment>
  </owl:Class>
  <owl:Class rdf:about="#RandomLengthPack">
    <owl:disjointWith>
      <owl:Class rdf:about="#CutToLengthPack"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#StandardMixedLengthPack"/>
    <owl:disjointWith rdf:resource="#SetLengthPack"/>
    <rdfs:subClassOf rdf:resource="#Pack"/>
  </owl:Class>
  <owl:Class rdf:ID="BrandName">
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >company-specific name for a particular product </rdfs:comment>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
  </owl:Class>
  <owl:Class rdf:about="#Softwood">    <rdfs:subClassOf
rdf:resource="#Species"/>
    <owl:disjointWith rdf:resource="#Hardwood"/>
  </owl:Class>
  <owl:Class rdf:ID="SoldAs"/>
  <owl:Class rdf:ID="Height">
    <owl:disjointWith>
      <owl:Class rdf:ID="Width"/>
    </owl:disjointWith>
    <rdfs:subClassOf>
      <owl:Class rdf:ID="CrossSection"/>
    </rdfs:subClassOf>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
```

```
    >Measurement of the object extents along its longest
dimension.</rdfs:comment>
  </owl:Class>
  <owl:Class rdf:ID="SquareMeter">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#UnitOfSale"/>
    </rdfs:subClassOf>
  </owl:Class>
  <owl:Class rdf:ID="Meter"/>
  <owl:Class rdf:about="#Grade">
    <owl:disjointWith>
      <owl:Class rdf:about="#Seasoning"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Species"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Dressing"/>
    </owl:disjointWith>
    <owl:disjointWith>
      <owl:Class rdf:about="#Size"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Construction"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Profile"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
  </owl:Class>
  <owl:Class rdf:ID="Visual">
    <rdfs:subClassOf rdf:resource="#Grade"/>
  </owl:Class>
  <owl:Class rdf:about="#Seasoning">
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Size"/>
    </owl:disjointWith>
    <owl:disjointWith>
      <owl:Class rdf:about="#Dressing"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Grade"/>
    <owl:disjointWith rdf:resource="#Construction"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Profile"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Species"/>
  </owl:Class>
  <owl:Class rdf:about="#CutToLengthPack">
    <rdfs:subClassOf rdf:resource="#Pack"/>
    <owl:disjointWith rdf:resource="#StandardMixedLengthPack"/>
    <owl:disjointWith rdf:resource="#SetLengthPack"/>
```

```
    <owl:disjointWith rdf:resource="#RandomLengthPack"/>
  </owl:Class>
  <owl:Class rdf:ID="PackUnit">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#UnitOfSale"/>
    </rdfs:subClassOf>
  </owl:Class>
  <owl:Class rdf:ID="Millimeter"/>
  <owl:Class rdf:about="#Dressing">
    <owl:disjointWith rdf:resource="#Seasoning"/>
    <owl:disjointWith rdf:resource="#Construction"/>
    <owl:disjointWith rdf:resource="#Grade"/>
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Size"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Species"/>
    <owl:disjointWith>
      <owl:Class rdf:about="#Profile"/>
    </owl:disjointWith>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
  </owl:Class>
  <owl:Class rdf:about="#Profile">
    <owl:disjointWith>
      <owl:Class rdf:about="#Size"/>
    </owl:disjointWith>
    <owl:disjointWith rdf:resource="#Construction"/>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
    <owl:disjointWith rdf:resource="#Grade"/>
    <owl:disjointWith rdf:resource="#Seasoning"/>
    <owl:disjointWith rdf:resource="#Species"/>
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
    <owl:disjointWith rdf:resource="#Dressing"/>
  </owl:Class>
  <owl:Class rdf:about="#CrossSection">
    <rdfs:subClassOf>
      <owl:Class rdf:about="#Size"/>
    </rdfs:subClassOf>
    <owl:disjointWith>
      <owl:Class rdf:about="#NominalSize"/>
    </owl:disjointWith>
  </owl:Class>
  <owl:Class rdf:about="#Width">
    <rdfs:subClassOf rdf:resource="#CrossSection"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >The extent side to side in the along a dimension shorter than an object's
length.</rdfs:comment>
    <owl:disjointWith rdf:resource="#Height"/>
  </owl:Class>
  <owl:Class rdf:about="#Size">
```

```
    <owl:disjointWith rdf:resource="#Construction"/>
    <owl:disjointWith rdf:resource="#Species"/>
    <owl:disjointWith rdf:resource="#Grade"/>
    <rdfs:subClassOf rdf:resource="#Attributes"/>
    <owl:disjointWith rdf:resource="#Seasoning"/>
    <owl:disjointWith rdf:resource="#Profile"/>
    <owl:disjointWith rdf:resource="#Dressing"/>
    <owl:disjointWith rdf:resource="#SurfaceFinish"/>
  </owl:Class>
  <owl:Class rdf:ID="Durability">
    <rdfs:subClassOf rdf:resource="#Grade"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >refers to resistance of HEARTWOOD (generally within 50mm radius of
the tree centre) to attack by fungi and insects when the timber is exposed to
all conditions of high decay and termite hazard.
Class 1 - Very durable with a service life in excess of 25 years
Class 2 - Durable with service life between 15 and 25 years
Class 3 - Moderately durable with a service life between 5 and 15 years
Class 4 - Non-durable with a service life less than 5 years</rdfs:comment>
  </owl:Class>
  <owl:Class rdf:ID="TimberProducts"/>
  <owl:Class rdf:about="#UnitOfSale">
    <rdfs:subClassOf rdf:resource="#TimberProducts"/>
  </owl:Class>
  <owl:Class rdf:about="#NominalSize">
    <owl:disjointWith rdf:resource="#CrossSection"/>
    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
    >This is the size of the timber, before it was machined</rdfs:comment>
    <rdfs:subClassOf rdf:resource="#Size"/>
  </owl:Class>
  <owl:Class rdf:ID="Treatment">
    <rdfs:subClassOf rdf:resource="#Attributes"/>
  </owl:Class>
  <owl:ObjectProperty rdf:ID="isPreparedIn">
    <rdfs:domain rdf:resource="#Pack"/>
    <rdfs:range rdf:resource="#SoldAs"/>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#InverseFunctionalProperty"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="isSoldIn">
    <rdfs:domain rdf:resource="#SoldAs"/>
    <rdfs:range rdf:resource="#UnitOfSale"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="classifiedAs">
    <rdfs:range>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#Hardwood"/>
          <owl:Class rdf:about="#Softwood"/>
        </owl:unionOf>
```

```
      </owl:Class>
    </rdfs:range>
    <rdfs:domain rdf:resource="#Species"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="isA">
    <rdfs:domain rdf:resource="#Pack"/>
    <rdfs:range>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#CutToLengthPack"/>
          <owl:Class rdf:about="#RandomLengthPack"/>
          <owl:Class rdf:about="#SetLengthPack"/>
          <owl:Class rdf:about="#StandardMixedLengthPack"/>
        </owl:unionOf>
      </owl:Class>
    </rdfs:range>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="SIconvert">
    <owl:inverseOf rdf:resource="#SIconvert"/>
    <rdfs:domain>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#Meter"/>
          <owl:Class rdf:about="#Millimeter"/>
        </owl:unionOf>
      </owl:Class>
    </rdfs:domain>
    <rdfs:range>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#Meter"/>
          <owl:Class rdf:about="#Millimeter"/>
        </owl:unionOf>
      </owl:Class>
    </rdfs:range>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#SymmetricProperty"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="representation">
    <rdfs:domain>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#Meter"/>
          <owl:Class rdf:about="#Millimeter"/>
        </owl:unionOf>
      </owl:Class>
    </rdfs:domain>
    <rdfs:range rdf:resource="#Size"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="includes">
```

```
    <rdfs:domain rdf:resource="#TimberProducts"/>
    <rdfs:range rdf:resource="#Attributes"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="isPreparedBy">
    <rdfs:range rdf:resource="#Mill"/>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#FunctionalProperty"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="comesFrom">
    <rdfs:domain rdf:resource="#Mill"/>
    <rdfs:range rdf:resource="#TimberProducts"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="TimberProducts_ObjectProperty_3">
    <rdfs:domain rdf:resource="#SoldAs"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="partOf">
    <rdfs:domain rdf:resource="#Size"/>
    <rdfs:range rdf:resource="#SI-system"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="isMadeFrom">
    <rdfs:range>
      <owl:Class>
        <owl:unionOf rdf:parseType="Collection">
          <owl:Class rdf:about="#Solid"/>
          <owl:Class rdf:about="#FingerJointed"/>
          <owl:Class rdf:about="#MediumDensityFibreboard"/>
        </owl:unionOf>
      </owl:Class>
    </rdfs:range>
    <rdfs:domain rdf:resource="#Construction"/>
  </owl:ObjectProperty>
  <Treatment rdf:ID="LOSP"/>
  <Profile rdf:ID="Batten"/>
  <Profile rdf:ID="Fascia"/>
  <Profile rdf:ID="DoubleRebatedSawnNoiseBarrier"/>
  <Profile rdf:ID="Cladding"/>
  <Profile rdf:ID="SingleRebatedSawnNoiseBarrier"/>
  <Profile rdf:ID="Decking"/>
</rdf:RDF>
```

Appendix E

(This appendix contains, on compact disc the raw data from the questionnaire, in a SPSS version 12.0.1 file)