27th Australasian Transport Research Forum, Adelaide, 29 September – 1 October 2004

Paper title: **The evaluation of e-business related technologies in the railway industry**

Author(s) name(s): Clara Tetther and Luis Ferreira

Organisation(s): School of Civil Engineering, Queensland University of Technology

Contact details:

Postal address: Queensland University of Technology
GPO Box 2434 Brisbane QLD 4001, Australia
Telephone: 07 3864 5086
Facsimile: 07 3864 1515
email: c.tetther@qut.edu.au, l.ferreira@qut.edu.au

Abstract (200 words):
Little research has been conducted either into how e-business technology can be successfully evaluated, or into the associated costs and benefits specifically related to transportation. Based upon a review of the current literature and a series of interviews held with major transportation customers, the paper puts forward a framework for the evaluation of e-business investments within the railway industry. The research reported here is aimed at developing a flexible interface that enables the decision maker to assess and evaluate a wide variety of complex interacting variables. An attempt is being made to include the complex interaction between the implementation of the new technology and the changing organisational setting. A model is proposed using fuzzy logic to handle incomplete and uncertain knowledge; as well as to combine criteria within a conceptual model from which 'real-worth' evaluations can be performed. After discussing the main findings from a literature review on the use of evaluation frameworks in IT related projects, the paper deals with the proposed framework in detail. The use of empirical data, which was obtained from transportation customers to help define the main framework factors, is also discussed. Finally, the paper summarises the main implications for rail freight of customer's perceptions and stated needs in the e-business domain.

Introduction

Despite numerous scares associated with the technology crashes in the late nineties, the market for e-business services continues to grow. It is clear that the transportation industry will continue to operate in an increasingly e-enabled environment in the future (Smith et al. 2003a). The anticipation is that emerging e-business technologies will be used to create a more effective and efficient transport service. This will be achieved through the use of technology, such as scanning, real-time data access, data warehousing and data mining techniques, sophisticated applications and intelligent management information systems.
As new technologies rapidly hit the market, businesses have to make critical investment decisions without adequate understanding as to the full implications that the technology might have on the current processes and culture of the organisation. Hidden inhibitors, such as employee reluctance to adapt and customer non-acceptance, may either inhibit the successful conclusion of a project or extend the original scope such that the original cost and investment return are severely compromised.
This paper is structured as follows; after a brief synopsis on the literature review, a summary is given of the findings of a survey of industry players from amongst companies in the Australian Fortune 50. This is followed by a discussion of the proposed evaluation framework. The development of the framework is dealt with in detail, including the conceptual model used and the main risk factors incorporated. Finally, some overall conclusions are put forward.

Evaluation methodologies: literature review

Background

In the late 1990's and early 21st century many organisations found that their Information Systems/Information Technology (IS/IT) budgets, and their e-business budgets, have been rising dramatically with little evidence of the promised financial returns (Sethi et al. 1993). Many references have expounded on the numerous potential benefits to be gained by e-business and new technology implementation. However, much of this literature appears to emanate from those with direct commercial interests, and little offers empirical analysis of early theoretical claims and promises(Barnes et al. 2002).

Railways are not newcomers to communication technology, with many organisations having had EDI implemented for a number of years. The e-business environment tends to be a "collaborative" one moving towards an integrated supply chain. This indicates that the greater risk and inhibitor for the railways may be their reluctance to collaborate (Smith et al. 2003b). Little has been documented on the potential barriers to adopting e-business and information technologies due to this cultural shift. Anecdotal evidence indicates that sophisticated technology projects in transportation have been delayed or failed due to these traditional "cultural/mindset" factors, along with a general conservative fear of sharing tacit knowledge with both competitors and partners (Mitev 1996).

Recently, as the focus on e-business has begun slowly to shift towards more empirical analysis, there has been some questioning of the promised productivity gains assessed in the initial evaluations (Pinsonneault et al. 1998). Hence, the IT productivity paradox

(Brynjolfsson 1993). Benefits previously heralded in original cost/benefit analysis, such as direct financial gains from reduction of the workforce and hardware use (Orli et al. 1987); savings from avoiding increases in work force (Smith 1983); and savings from future system modification and/or enhancement costs (Vaid-Raizada 1983), are concurrently disputed by experience and ex-post cost analysis studies.

Quantifying costs and benefits

Traditional theories of information technology have tended to classify costs and benefits into quantifiable contributions from process and resource control, hardware and software savings, improvements in productivity, contributions to system restructuring capability, and contributions to resource utilisation (King et al. 1978).

The latest research, however, is showing that there are many hidden costs and benefits associated with the implementation of e-business systems. Such impacts can be considered intangible and are often within areas previously not measured on the income statement. Factors which are strategic in nature (Phan 2002); social (Ryan et al. 2002); and within the culture of the organisation (Krumbholz et al. 2000), fall under this broad category. Additionally, early evidence from pioneering industries, such as banking, have shown that the adoption of e-business is not as predictable as once thought. The capacity to convert or acquire customers varies due to not only social and demographic factors but also between the organisations themselves (Bughin 2003).

The difficulties in quantifying these types of inpacts arise due to two main factors. Firstly, the problems in defining these potential costs and benefits due to the iconoclastic nature of e-business technology implementation. (Kalakota et al. 2001). Secondly, the difficulty in defining "value" and "cost" of intangible benefits in monetary terms ((Irani et al. 2002a; Murphy et al. 2002), amongst others).

Evaluation methods

Current evaluation methods have been categorised into four distinct methods of analysis (Patel et al. 1999). These have been termed the economic, strategic, analytical and integrated approaches. Economic approaches have been criticised, as the evaluator must derive monetary values for all criteria to ensure the analysis is complete.

Strategic approaches are either purely judgemental or have been considered to esoteric for practitioners and their use is often considered somewhat risky (Paul et al. 1999). Analytical approaches have been criticised for being too subjective and easy to misuse in application to IT investments (Kaplan 1986). Integrated approaches appear to offer the most successful approach, as they comprise of two or three compilations of the methods previously mentioned.

However, all methods have been criticised for being mono-dimensional and non-dynamic. Hence, there is still a focus on the inadequacy of current available methods to assess emerging technologies ((Anandarajan et al. 1999; Doherty et al. 2002; Farbey et al. 1993; Fitzgerald 1998), amongst others).

Until very recently, literature still appeared to argue that intangibles should be converted into monetary terms in order to be "measurable". However, there is evidence that businesses are starting to grapple with the issues of placing dollar values on intangibles such as intellectual property, sustainability and competitive advantage. It is difficult to convert a factor that is initially difficult to measure into a dollar amount and recent literature is recognising that there are alternative measures of value (Lim et al. 2001).

In e-business evaluation, not only are there many benefits that cannot be easily quantified, but their value may be different to each stakeholder (e: the direct user, the organisation, and the customer). In order to successfully evaluate e-business implementation in the transport sector, a paradigm shift is required. Firstly, in the fundamental understanding of the quantification of value as regards intangibles. Secondly, a shift is required from the traditional view of transportation as a stand-alone system within the supply chain with the customer as its commodity. The supply chain needs to be viewed as a whole and value being measured in the ability to drive efficiencies throughout or in any part of it.

Industry interviews

Due to a general paucity of literature specifically related to e-business in the transport industry, alternative methods of data collection such as face-to-face industry interviews, were chosen in conjunction with the literature review. This approach was chosen to gain a better understanding of the main issues that could impact e-business implementation within the railway industry. A greater understanding of the state of e-business trends within the Australian supply chains was also gained from the interviews. By predicting the efficiencies and cost reduction opportunities e-business initiatives bring to the supply chain as a whole, the impact on the industry can be assessed.

National logistics and information systems managers from within the largest Australian Fortune 50 companies participated in the study. The interests of the companies ranged from retail, automotive, resources, agriculture and media. This has produced some clear insights into the current trends and future requirements at the "customer" end of the supply chain and the implication of these trends on the future of the railway industry.

Results and analysis

The results are summarised into three general sections as listed below:

- IT and transportation - benchmarking the supply chain
- IT: fears and inhibitors
- IT: future issues

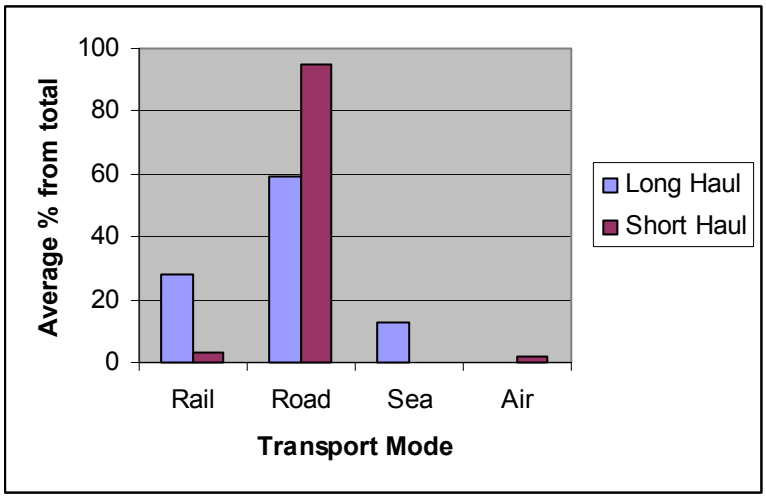

Figure 1 Survey respondents - usage of transportation modes

IT and transportation - benchmarking the supply chain

Freight selection criteria: All respondents are involved in the transportation of bulk freight, whilst the majority all had interests in general freight and a minority handled dangerous goods, refrigerated and live freight. All respondents were involved in interstate transportation, whilst the majority were involved in short haul, urban and non-urban. A minority were involved in international transportation.

In its current state, rail was viewed as an ineffective transport solution for just-in-time (JIT), short haul and "time sensitive" goods by all respondents. This was due to:

- Little reliance and confidence in rail reliability for time sensitive freight;
- Limited flexibility with rail; and
- Double handling complications such as delays, losses due to evaporation (liquid freight) and subsequent additional costs.

However, nearly all respondents agreed there are parts of their business, specifically long haul (eg trips over 800km), and "time certain" goods, for which rail transport would be a feasible option if the confidence in the reliability in rail could be increased. New technology was viewed as a potential means to increase control and efficiency of the rail service and hence an opportunity for rail to win market share.

However, it was stressed that the mere implementation of technologies, such as track and trace facilities; electronic trading documentation exchange; electronic financial transactions (EFT); and electronic reporting capabilities, would not be sufficient to increase this level of confidence. The absence of such facilities will also significantly disadvantage the logistics provider.

Effective and "smart" use of these technologies, however, could potentially enhance control over scheduling, modelling (intelligent consignment and adaptability support), intermodal interchanges, and security, and improve overall reliability and flexibility of the service. Efficient use of this technology to improve reliability could potentially raise rail's position in the market. It is estimated that from one company alone this could result in increased revenue of approximately $12 million a year for rail.

The Australian Supply Chain: Overall, most respondents felt that the Australian supply chain stands on average 5 years behind its UK and USA counterparts (there were some areas where it was felt that it is a few years ahead, whilst in other areas it was felt that Australia lagged 10 years behind).

All respondents felt that there was a technology gap, due to inadequate understanding of how to use the technology effectively to drive efficiencies along the whole of the supply chain. Reasons for this gap include a conservative traditional mindset in the transportation industry as a whole; a general fear of thinking beyond the traditional processes to use technology to drive initiatives; and a fundamental lack of understanding of core customer needs and requirements.

For example, it was felt by many respondents that logistics was quickly becoming more complex. Transport should no longer be viewed as the "dumb" link but as a more complex and controlled part within the supply chain. Hence, many organisations are looking for future transportation companies to provide the knowledge and expertise to compete in a technical

efficient logistical environment. Several respondents stated that the organisation would be happy to invest in an opportunity that allows the transport function responsibility to be taken away from their core business.

Technology: Fears and Inhibitors

The four main concerns were given as follows:

- Lack of national standards in transportation;
- Growing concern with "chain of responsibility" as supply chain and relationships between parties become more integrated ;
- Security (especially in regards to wireless technology); and
- Growing concerns with privacy issues associated with the growing use and implementation of RFID technology.

Lack of standards in transportation: All respondents felt that the lack of standards across the supply chain and within the transport function, not only inhibits the creation of a "seamless flow of information", but would also creates unnecessary future costs, for all parties within the supply chain. Issues cited included standardisation of data collection formats to enable real-time build up of freight trip origin-destination matrices; equipment identification to enable high-speed data transfer and ownership of data; and interface standards such as XML schemas. Because of these concerns, many of these organisations have already commenced global standardisation negotiations between their suppliers and partners.

This has two implications for transportation companies: Firstly, the lack of standardisation within the transportation industry means that there will be potential delays and weaknesses in the transfer of data across the supply chain. Secondly, as many customers are already in the process of implementing their own data and interface standards, it is imperative that transporters build their systems with adaptability and within platforms that can readily deal with a variety of legacy systems, data formats and interfaces.

Chain of responsibility: It was felt that although this issue was an indirect consequence of technology, it is one that was of a serious concern. As the transport function becomes more integrated in the supply chain, the boundaries of responsibility also become intertwined.

Security: The threat is from domestic, foreign terrorists and enemies who may seek to disrupt the supply chain by intercepting and tampering, either with the flow of digital information or with the freight itself. As the threats of bio-terrorism become more real, alternatives may need to be investigated, such as implementation of e-seal technology, in conjunction with the implementation of sophisticated track and trace. Security may also act as an inhibitor to the implementation of technology (eg: wireless technology). Some respondents claimed that their organisation was currently not going to implement wireless technology, due to fears of interception and tampering from outsider parties.

Customer-transporter working relationships: The respondents seem to break into two distinct groups on this issue. Those that were driven by the traditional cost/efficiency and time sensitive issues; and those that were moving towards a more "sustainable" model of the supply chain, driven additionally by control/integrity/sustainability. The inhibitors for total collaboration and integration within this relationship were mainly seen as the lack of standards; reluctance between the transport companies to collaborate with traditional

competitors; and an overall view of the customer as a 'commodity', rather than a partner within the supply chain as a whole.

Some organisations were looking to further collaborate with their transporters and enhancing the relationship towards shifting control to the transport providers. It was felt by these respondents that technology implementation was enabling transport providers to be keepers of usable and valuable information.

Technology: Future Issues

The paradigm shift in logistics is being further driven by increasing consumer and legislative demands for historical data on the transportation history of goods. As threats from terrorism continue and litigation requirements demand more accurate historic data and analysis, it will become necessary for organisations to implement the capacity to collect and safeguard such data. This future requirement may put pressure on transporters to collect and maintain historic data in order to comply with future international and national legislation and requirements. Much of the preliminary technology to collect such data is already being implemented with little thought on the analysis and future data mining requirements. The increasing requirement for data means that substantial amounts of information will need to be transported along with the freight itself. Unless the flow of this data is digital and "seamless" this could potentially cause considerable costs, delays and potential errors.

The interviews have shown that the greatest growing demand appears not to be for the technology itself but for the information that the technology can gather and analyse. How this information is transferred and reported is then reliant on the e-business systems in place. All respondents claimed that they would like to see such advantages from technology as on-line reconsignment instructions and adaptability support; on line real-time data on transit times/real costing; and on-line customer centric reporting.

The Evaluation Framework

Based on the findings of the literature review and the results of industry surveys, a model for the evaluation framework was developed. As shown in Figure 2, the model has been formulated on three levels, namely:

Level 1 – Impact categories

Level 2 – Expected impacts

Level 3 – Model implementation

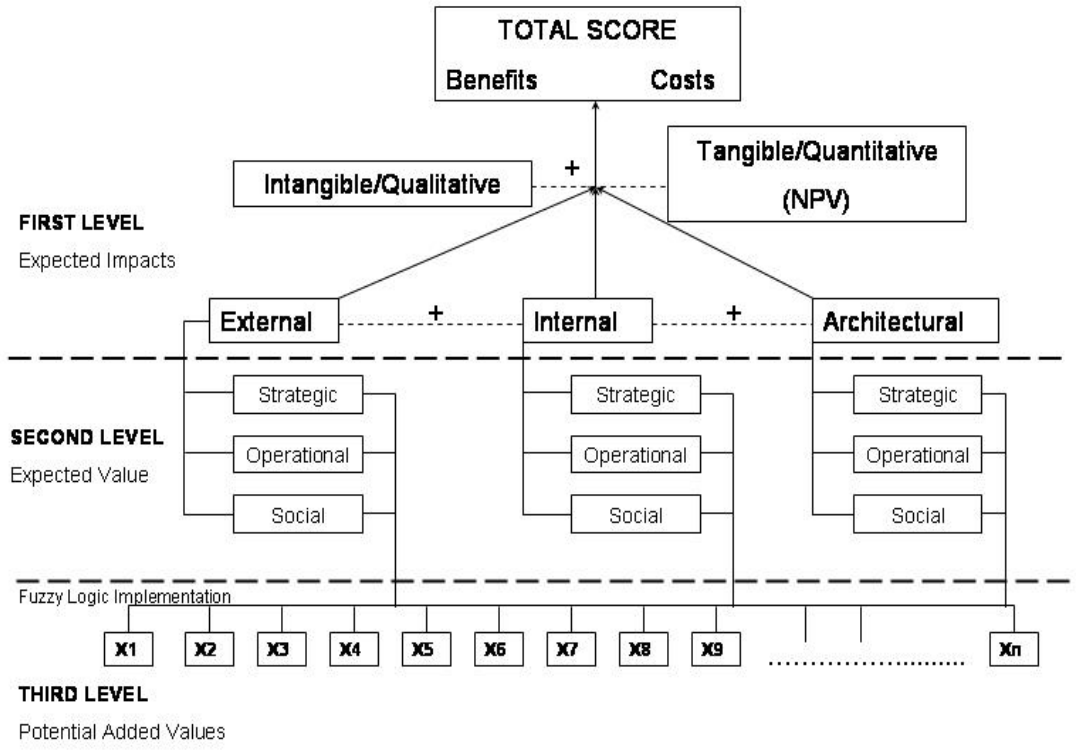

Figure 2 Conceptual Framework Structure

Level 1 – Impact categories

Experience has shown that an e-business system is fundamentally a communicative and collaborative one, extending and enhancing communications internally between organisational sectors, and externally between partners, customers and even potential competitors and saboteurs. Surveys have shown that current attitudes and trends, traditional values, organisational cultures, and even aspects such as the current economic environment and global directives can indirectly affect the acceptance and uptake of technology. Hence, an evaluation assessment must take into account these external relationships and the totality of the impact on their structure, as well as the potential throwback to the internal dimensions within the organisation.

Empirical data on post-implementation costs conducted in global industries such as retail, automotive, amongst others, has shown the potential additional costs which have occurred due to lack of standardisation within the basic architecture of a system. Quantitative costs include additional software upgrades, consultant and programming costs. Threats to the successful implementation of an e-business system include potential integration problems, delays in data transference, data redundancies and delays, and errors in any manual data entering. The surveys confirm that this experience has been global, with many organisations commencing to formalise data and interface standards, both amongst their industrial partners and their competitors.

Hence, it is concluded that to enable one to undertake a realistic assessment of an e-business system, one must have a holistic view, that is, extend beyond the boundaries of sectors and organisation and consider both the external and internal categories. Additionally, fundamental to the efficient working of a communication system is the backup infrastructure, in this case, platforms that allow easy integration between a variety of systems.

Thus, we begin to see that hidden costs and benefits may lie within three main categories; 1) the digital pathway to, and the congress between organisation and external parties, 2) the relationships and the network between those relationships within the organisation, and 3) the fundamental architecture of the system. To maximise benefit and minimise potential costs, it would appear that each category must be minimally compromised, with dependencies within each category defined and satisfied.

Figure 3 shows the three categories which have been defined as:

Internal Environment: Made up of factors within the business function, such as the infrastructure readiness; employee readiness and skill sets; availability of resources; and cultural inhibitors, that may be impacted through the implementation of the technology.

External Environment: Made up of factors external to the business, such as customer relationships; external infrastructure weaknesses and limitations; current trends in the industry; and government legislation, which may have potential impact on the organizational function.

Architecture: Made up of factors identified with the technical structure of the organization, such as lack of standardization of data; weak legacy systems; lack of direction in interface ownership; which have the potential to impact the project outcome and realization of requirements.

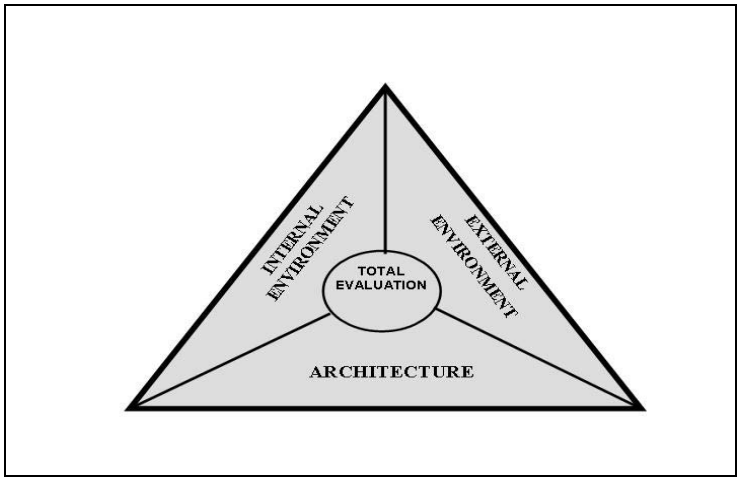

Figure 3 Evaluation Categories

Level 2 – Expected impacts

Within each category lies quantifiable and non-quantifiable potential costs and benefits. It is intended that quantifiable benefits be evaluated using traditional economic approaches. Prior to evaluating the non-quantifiable costs and benefits, it is necessary to group them into dimensions, which have been identified as adding value to the business. The dimensions to be used are shown on Figure 4. The definitions used for strategic and operational have been adapted from previous work by Irani (Irani et al. 2002b). A further dimension "social" has

been added due to the findings of recent post-implementation data and interpretation of interview data on the potential future risks to the successful implementation of e-business systems within the transportation industry.

Strategic: Evidence has shown that those that implement e-business systems from a "strategic" stance can reap substantial benefits (Power 2002). Strategic costs and benefits can be defined as factors that can potentially either enhance, inhibit or destroy processes that are important to the effective conduct of the business. Strategic factors include but are not inclusive of considerations that move towards sustainability; impact on competitive advantage; align with the vision; impact on interoperability; and impact on the flow of information across the supply chain. The strategic nature of an option is dependent on factors which can be considered perceptive, hence the weighting factors determining the value of the benefit could be perceived as being subjective. Thus a tool is required to enable these factors to be "surmised" but to minimise the subjectivity on the total score.

Operational: Operational factors are usually quantifiable. These are factors that impact on the operational processes of the business on a day-to-day level. Where factors are non-quantifiable, the level of benefit will be determined by the potential impact on efficiency, effective use of resources, effective use of tacit knowledge.

Social: Both the literature and anecdotal evidence from the industry interviews have stressed the potential impact of this factor on the ultimate successful completion of an e-business project. E-business implementation does not change the ultimate business process, and although it digitises the flow of information, in many circumstances the information stays the same. It does, however, change the fundamental way in which parties communicate that information. Tacit knowledge conveyed easily through face-to-face contact often is not as easy to communicate digitally. These types of factors display hidden costs and complications to the flow of information required.

Additionally, it is critical to assess problems or factors that may inhibit or prohibit the system supplying maximum benefit, within the architecture or technical infrastructure of the system. In terms of the transportation company, this will entail looking at the "virtual" supply chain as a holistic function. Technical functions, internal business processes and partnerships and relationships between customers, intermodal partners and competitors, all contribute to the seamless flow of freight from its origin to its final destination.

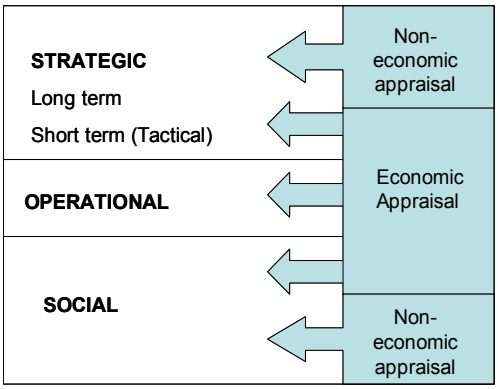

Figure 4 Measures of Value (adapted from Irani et al 2002)

Risk Factors: Two important risk criteria can affect the ease in implementation and acceptance of new technology, namely:

- the technical maturity of the organisation or sector; and
- the business maturity of the organisation.

These are dynamic components which are calculated as separate risk factors. These are calculated using current knowledge of the organisations infrastructure, management strategies and technical capabilities, and then applied as a risk score to the summation of benefits.

Level 3 – Model implementation using Fuzzy Logic

The findings from the industry interviews and the literature point to the fact that organisations are becoming increasingly aware of the hidden intangible costs and benefits. However, the problems arise in how to summarise and "value" them in a manner that will enable a decision maker to analyse their impact. The evaluation process has more to do with fuzziness rather than randomness as a major source of imprecision. It has been suggested that in such situations it is appropriate to handle the uncertainty via fuzzy set theory which has been shown to be a useful tool to hand such imprecision (Kacprzyk et al. 1995; Zadeh 1965).

Unlike other decision making tools, however, the decision maker is not faced initially with a variety of alternatives. The fuzzy technique is used instead to provide consistency in a complex subjective situation by effectively minimising the problems of individual judgement. It also provides some clarity where fuzziness in perception is caused by the complexity that cannot be comprehended at once. The attributes, which will define the weightings within the fuzzy tool, will be determined from expert data gathered from post-analysis empirical research and industry interviews.

The final level of the model will take the three dimensions specified above and break each of those further into sub-dimensions. Each sub-dimension comprises of a factor that is an acknowledged result from the implementation of a system, for example "online dissemination with customers". The value of this factor will be calculated from the summation of its features and the aggregation of the linguistic attributes evaluated within the fuzzy tool. Linguistic attributes will consider perceptive values relevant to that factor, such as the demand for that factor, the alignment with the organisation e-business vision and the availability of tacit knowledge required.

It is proposed that the user interface of the system will be presented as in Figure 5, where the available features of the factor (online dissemination with customers) stated above are listed. For each feature, the evaluator specifies which user will be gaining value from the feature and at what value will that benefit or risk felt. The final "value" of the factor will be the summation of potential benefits and costs, and the aggregation of these will give a final score for the strategic, operational and social dimensions. Only relevant features will be listed for each factor, so each interface will be constructed pertinently to the factor being evaluated.

The final assessment or score is given by analysing the ratio between the aggregated score of benefits over costs. The assessment is made separately for each stated category; namely, internal, external and architecturally.

By using the results from industry interviews to compile the preliminary lists of benefits and potential hidden costs, it is intended that the rules, standards and criteria for implementing the model will be assessed by potential practitioners. Further interviews will be conducted to refine the process.

Conclusions

The literature on post-implementation of e-business systems indicates that critical intangible factors that often were not initially assessed in the original justification process have considerable impact on the successful implementation of such systems. The reasons for this were found to be that traditional appraisal methods tended to focus on financially tangible benefits, with the larger strategic, social and cultural dimensions often missing from the assessment. This has been confirmed by the results of the industry interviews.
The interviews identified that the implementation of IT technologies only added real value to the supply chain if:

- it improved reliability and flexibility of the service;
- it provided smart information in a format that was usable to drive efficiencies;
- it minimised potential areas of data congestion and redundancies;
- it created a platform for sustainability;
- it was used as an analytical tool to drive efficiencies throughout the whole of the supply chain; and
- it was used to enhance collaborative development with partners on either end of the supply chain.

These factors give us an indication of how to obtain maximum value from the implementation of the technology. However, it is evident that these factors will not be fulfilled unless there is a real understanding of customer demands and requirements, as well as a full understanding of the supply chain and the data requirements to drive efficiencies within it.

The model proposed here will serve as an aid to the decision maker by giving greater understanding of the potential hidden costs and benefits involved in the implementation of e-business systems.
In summary it is proposed that the model poses three questions:

- What types of benefits and potential hidden costs will be achieved by the implementation of the system?
- What value will these add to the supply chain and the organization?
- What potential compromises will be required to achieve that value and how significant will those compromises be?

Hence the model is proposed as an analytical tool which has the ability to highlight, analyze and summarize quantitatively those costs and benefits which previously may have been ignored. This ensures a more holistic assessment of each category and minimizes subjectivity. Ultimately, however, the evaluator is in control of the decision-making process and the framework is there merely to give guidance and highlight risks and pitfalls.
Further work is needed to refine the model and gather more data on the costs and benefits to operator, regulator and private enterprise within the railway industry. Additionally further work will also be required on testing and reviewing the model within a real e-business system implementation

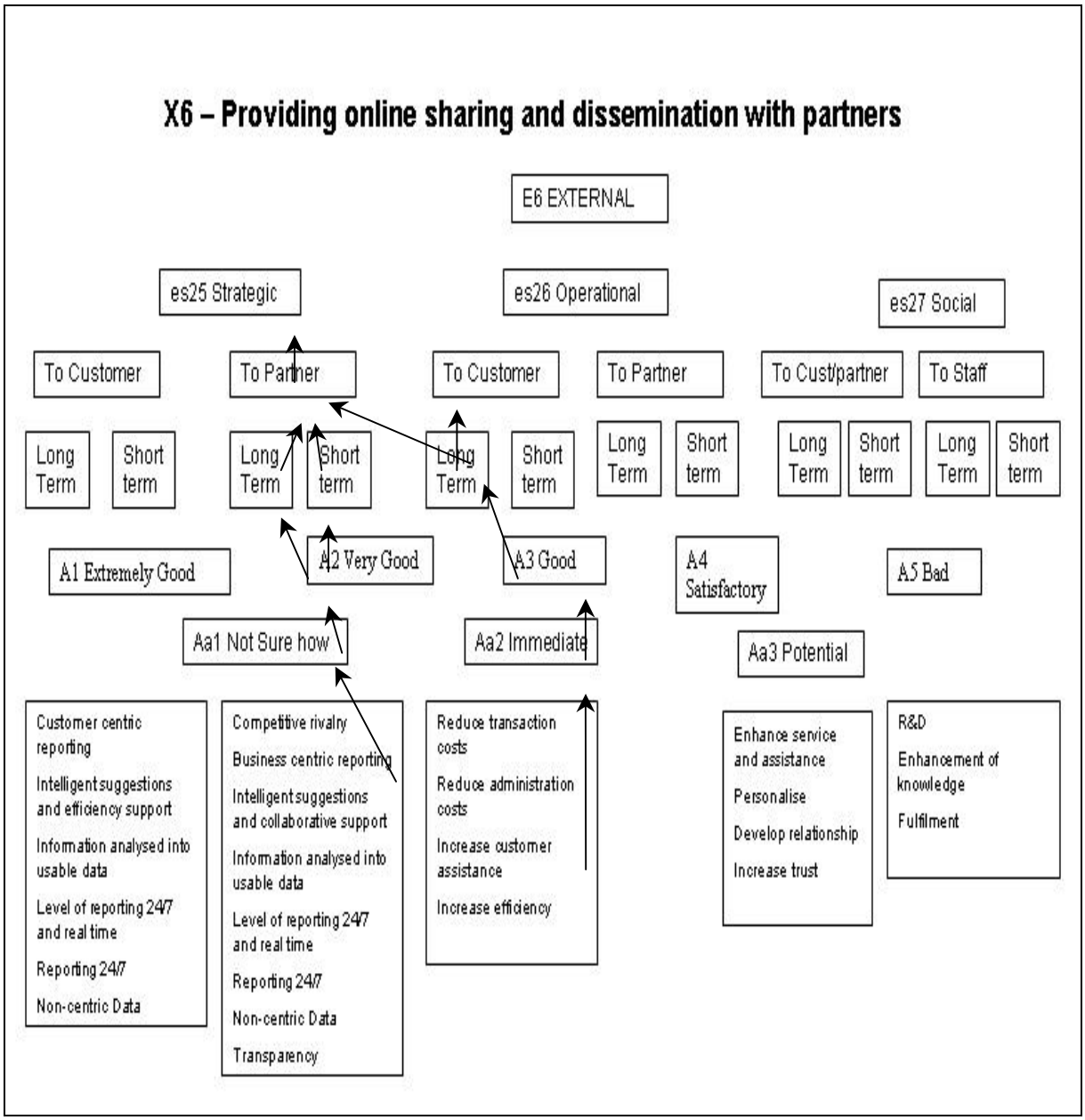

Figure 5 Factor assessment conceptual interface structure

Acknowledgements
The authors gratefully acknowledge the continuing funding and support for this work from the Railway Cooperative Research Centre (CRC) as part of Project 10 Theme 4 "IT Systems, Standards for Rail Management", and personally extend that thanks to all the members of the CRC Steering Committee for their ongoing support and assistance. Additionally, the authors would also like to extend a sincere thank-you to all the participants in the survey, both for sharing their valuable time to partake in the interview, and for the effort and sincere consideration employed in formulating the answers, and ensuing discussion of the topics.

References

Anandarajan, A., and Wen, J.H. "Evaluation of Information Technology Investment," *Management Decision* (37:4), 1999 1999, pp 329-337.
Barnes, D., Hinton, M., and Mieczkowska, S. "Developing a Framework to Investigate the Impactof E-commerce on the Management of Internal Business Processes," *Knowledge and Process Management* (9:3), 2002 2002, pp 133-142.
Brynjolfsson, E. "The productivity paradox of information technology," in: *Communications of the ACM*, 1993, pp. 67-77.
Bughin, J. ""Attack or convert?" early evidence from European on-line banking," *International Journal of Management Science*) 2003.
Doherty, N.F., and McAulay, L. "Towards the formulation of a comprehensive framework for the evaluation of investments in sell-side e-commerce," *Evaluation and Program Planning* (25:2), 2002/5 2002, pp 159-165.
Farbey, B., Land, F., and Targett, D. "IT investment: A study of Methods and Practices," Mangement Today and Butterworth Heinemann Ltd, London, UK, 1993.
Fitzgerald, G. "Evaluation information systmes projects: A multidimensional approach.," *Journal of Information Technology* (13) 1998, pp 15-27.
Irani, Z., and Love, P.E.D. "Developing a frame of reference for ex-ante IT/IS investment evaluation," *European Journal of Information Systems* (11:1), Mar 2002a, pp 74-82.
Irani, Z., Sharif, A., Love, P.E.D., and Kahraman, C. "Applying concepts of fuzzy cognitive mapping to model: The IT/IS investment evaluation process," *International Journal of Production Economics* (75:1-2), 2002/1/10 2002b, pp 199-211.
Kacprzyk, J., and Fedrizzi, M. "Developing a fuzzy logic controller in case of sparse testimonies," *International Journal of Approximate Reasoning* (12:3-4), 1995/0 1995, pp 221-236.
Kalakota, R., and Robinson, M. "e-Business 2.0," Addison-Wesley, United States of America, 2001.
Kaplan, R.S. "Must CIM be justified on faith alone?," in: *Harvard Business Review*, 1986, pp. 87-95.
King, J., and Schrems, E. "Cost-Benefit Analysis in Information Systems Development and Operation," in: *Computing Surveys*, 1978, pp. 19-34.
Krumbholz, M., Galliers, R., Coulianos, N., and Maiden, N. "Implementing enterprise resource planning packaes in different corporate and national cultures," in: *Journal of Information Technology*, 2000, pp. 267-280.
Lim, D., and Palvia, P.C. "EDI in strategic supply chain: impact on customer service," *International Journal of Information Management* (21:3), 2001/6 2001, pp 193-211.
Mitev, N.N. "More than a failure? The computerised reservation systems at French Railways," *Information Technology & People* (9:4), 1996 1996, pp 8-19.
Murphy, K.E., and Simon, S.J. "Intangible benefits in valuation in ERP projects," *Information Systems Journal* (12:4), 2002 2002, pp 301-320.
Orli, R., and Tom, J. "If it's worth more than it costs, Buy it," in: *Journal of Information Systems Management*, 1987, pp. 85-89.
Patel, N.V., and Irani, Z. "Evaluating information technology in dynamic environments: a focus on tailorable information systems," *Logistics Information Management* (12:1/2), 1999 1999, pp 32-39.
Paul, R.J., Giaglis, G.M., and Hlupic, V. "Simulation of business processes," *The American Behavioral Scientist* (42:10), Aug 1999 1999, p 1551.
Phan, D.D. "E-business development for competitive advantages: a case study," *Information & Management* (In Press, Corrected Proof) 2002.

Pinsonneault, A., and Rivard, S. "Information technology and the nature of managerial work: From the productivity paradox to the Icarus paradox?," *MIS Quarterly* (22:3), Sep 1998 1998, p 287.
Power, D. "Implementation and usage of electronic commerce in managing the supply chain: A comparative study of ten Australian companies," *Benchmarking: An International Journal* (9:2), 2002 2002, pp 190-208.
Ryan, S.D., Harrison, D.A., and Schkade, L.L. "Information-technology investment decisions: When do costs and benefits in the social subsystem matter?," *Journal of Management Information Systems* (19:2), Fall 2002 2002, p 85.
Sethi, V., and Pegels, C. "Information Technology and organisational performance: A critical evaluation of computerworld's index of information systems effectiveness," in: *Information and Management*, 1993, pp. 193-205.
Smith, N., Ferreira, L., Salim, V., Marquez, L., Leon, J.d., and Gannon, J. "Adoption of eBusiness systems in the rail industry: Impediments and likely benefits," 2, CSIRO.
Smith, N., Salim, V., Marquez, L., and Leon, J.d. "Mapping information flows in the railway supply chain to determine stakeholers EBusiness requirements," 1, CSIRO, Brisbane.
Smith, R. "Measuring the Intangible Benefits of Computer-Based Information Systems," in: *Journal of Systems Management*, 1983, pp. 22-27.
Vaid-Raizada, V. "Incorporation of Intangibles in Computer Selection Decisions," in: *Journal of Systems Management*, 1983, pp. 30-36.
Zadeh, L. "Fuzzy sets," in: *Information & Control*, 1965, pp. 338-353.