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Human-knowledge resources and interorganisational systems

Mohammed Ibrahim,* Pieter M. Ribbers,† Bert Bettonvil‡

Tilburg University, Tilburg, Netherlands, *email: m.k.m.ibrahim@uvt.nl, †email: p.m.a.ribbers@uvt.nl, and ‡email: b.w.m.bettonvil@uvt.nl

Abstract. *This paper analyses how human-knowledge resources affect interorganisational systems (IOS) capabilities and subsequently attainment of operational and strategic benefits. A conceptual model is constructed combining the transaction cost economics (TCE) view, resource-based view (RBV) and insights from IOS literature. The model is tested through a triangulation approach combining two qualitative case studies and a quantitative field study within the logistics sector. This sector is chosen due to its need for high reliance on information technology. The findings indicate that human knowledge positively influences IOS capabilities related to cross-organisational business processes and transfer of knowledge. Findings also show that strategic benefits are the consequence of knowledge transfer, when the transfer supports business processes resulting in operational benefits. The main theoretical contribution of this paper is that it combines a TCE view and RBV to analyse the effect of relationship-specificity of human-based knowledge resources in IOS.*

Keywords: interorganisational systems, human knowledge, resource-based view, IOS capabilities, strategic benefits

INTRODUCTION

Organisations use various types of interorganisational systems (IOS) to facilitate their interorganisational relationships (IOR). The benefits of using such systems include operational benefits such as the efficiency of automating manual processes and strategic benefits such as creating new business opportunities (Buxmann *et al*., 2004). This paper focuses on long-term business relationships that utilise IOS to facilitate coordination and communication. Such IOS can entail specific configurations to enable frequent and intensive contacts. Human agents and interpersonal contacts are essential for supervising technological change, setting requirements, and determining IOS configurations (Teo & Ranganathan, 2003; Ibbott & Keefe, 2004; Bunduchi, 2005). Recently, increased attention is devoted to the influences of knowledge resources. Long-term business relationships aid organisations in improving their business processes, knowledge and learning capabilities (O'Callaghan & Andreu, 2006). Organisations

cautiously select business partners that possess the required resource profiles and learn during their relationships with them (Jones *et al*., 1998). However, little is known regarding how human knowledge influences the development of IOS capabilities within business relationships. The objective of this paper was to increase the understanding in this area by investigating the influences of human-knowledge resources on the use of IOS and consequent influences on performance. More specifically, we use the resource-based view (RBV) to provide a conceptual foundation to examine how relationship-specificity of human-knowledge resources influences the development of IOS capabilities. The theoretical contribution encompasses the development of a conceptual model that builds on multiple literature streams including literature on IOS, RBV, transaction cost economics (TCE) and knowledge management. Combining concepts from these various streams enables us to analyse human knowledge influences within different IOS contexts. The model postulates hypotheses on how human knowledge contributes to operational and strategic benefits through the realisation of IOS capabilities. The conceptual model is tested using two qualitative case studies and a quantitative field study within the logistics sector. The case studies facilitate in-depth analysis of the influences of human knowledge and the field study facilitates rigorous testing of the hypotheses.

The paper is organised as follows. Section two briefly discusses the literature on IOS, TCE and RBV. Section three discusses the development of the hypotheses. Section four describes the qualitative and quantitative data and examines their support for the hypotheses. Section five discusses the implications of the empirical findings and finally, section six concludes the paper.

LITERATURE REVIEW

The literature on IOS, TCE and RBV is discussed in this section.

IOS

To qualify as an IOS, it is necessary and sufficient for a system to be used by two or more organisations (Cash & Konsynski, 1985). IOS support interorganisational data exchange, interlinkage of processes across organisational boundaries and with that performance improvement (Mukhopadhyay & Kekre, 2002; Gallivan & Depledge, 2003; Buxmann *et al*., 2004; Subramani, 2004). Recently, increased emphasis is placed on the role of IOS to support interorganisational information sharing and knowledge transfer (Jones *et al*., 1998; Malhotra *et al*., 2005). Organisations gain access to additional information and increase their learning opportunities when they select business partners based on their knowledge resource profiles (Hitt *et al*., 2000). IOS facilitate effective relationships with multiple business partners enabling organisations to access a larger pool of knowledge and to realise competitive advantage.

Furthermore, IOS can support organisations in detecting changes within the environment by improving the quality of communication and enhancing the decision-making process (Ciborra & Andreu, 2002).

The transaction cost perspective

TCE attempts to explain firms' choices between internalising and buying goods and services from the market. TCE distinguishes two basic mechanisms for coordinating the flow of products and services: *markets* and *hierarchies*. In *markets*, supply and demand forces regulate the external transactions of material and immaterial goods between individuals and companies, determining design, price, quantity and delivery schedules. In the theoretical extreme case of atomic competition, there are no relations between buyers and sellers, or among buyers, or among sellers. The relation between a buyer and seller only exists for the duration of a particular transaction. In *hierarchies*, on the other hand, it is assumed that products and services are produced by the organisation that needs them. Production, availability and delivery are controlled and directed by managerial decisions at higher management strata.

Next to markets and hierarchies, a third way of coordinating the flow of goods and services has emerged: *long-term relationships between a smaller set of organisations.* Legally and economically independent organisations have agreed to give up, in principle temporarily, their autonomy with respect to a particular value exchange. Coordination with respect to value exchanges is achieved through joint planning and longer-term agreements. The extent to which autonomy has been given up will differ. Some organisations may be very tightly coupled to each other, leading to an intense information exchange, others very loosely.

In TCE, the choice for any one way of procuring goods and services is a matter of cost minimisation, in particular (the sum of) *production costs* and *transaction costs*. *Production costs* include the costs of physical or other primary processes necessary to create and distribute the goods or services being produced. *Transaction costs*, also called *coordination cost*s (Malone *et al*., 1987), include the costs of planning, adapting, executing and monitoring task completion (Williamson, 1981). In the case of market transactions, these will include search costs, contract costs and monitoring costs. In the case of in-house production, these will include the cost of planning and monitoring, like determining the design, price, quantity, delivery schedule and similar factors for products transferred between adjacent steps in the value chain. The basic concept is that a firm will decide to rely on a governance form that is closer to the hierarchical end of the spectrum than the market end when the transaction costs that arise from market coordination outweigh production cost benefits, which arise from economies of scale and scope that come with buying from specialised firms. Outside procurement is favoured when the sum of external production costs and transaction costs are lower than the sum of internal production costs and coordination costs.

The effects of information technology (IT)

Recent advances in computing and communications technology have affected the costs of coordination. This has changed the balance between markets and hierarchies, contributing to the rise of new strategies and structures, for individual companies and entire industries (Clemons *et al*., 1993).

One effect is that IT is leveraged to perform the essential market functions more efficiently and effectively. In this respect, Malone *et al*. (1987) formulated the *electronic market hypothesis*, and offered the prediction that electronic markets would become the favoured mechanisms for coordinating material and information flows among organisations in the presence of electronic communication technologies. The basic argument is that IT reduces the coordination costs between firms involved in supplier selection, price discovery, delivery scheduling and other activities associated with business transactions, enabling buyers to compare purchase alternatives at lower search costs, and to transact with business partners more efficiently (Malone *et al*., 1987). This leads to an overall shift towards proportionately more use of markets – rather than hierarchies – to coordinate economic activity (Malone *et al*., 1987).

However, researchers have found that IOS do not necessarily create unbiased electronic markets. In particular, they argue that the introduction of IT may result in fewer, rather than more, suppliers, despite the reduction in transaction costs (Hess & Kemerer, 1994). In this respect Clemons *et al*. suggest the *move to the middle hypothesis* (Clemons *et al*., 1993):

- There will be a greater degree of buying from the market, as IT increases information availability and processing capacity, and thus reduces transaction costs (that is, a move away from ownership and vertical integration).
- Companies will favour developing long-term value-adding partnerships with a small group of suppliers: companies will rely on fewer suppliers than before, with whom they will have close and long-term relationships and with whom they will cooperate and coordinate closely (that is a move away from market coordination).

The prediction that IT will lead to the development of long-term, close relationships between buyers and sellers is based on three arguments as well:

- Long-term relationships allow companies to recoup their investments in human relationships and organisational processes; they also provide their suppliers with an incentive to make the investments required;
- The degree to which IT reduces coordination costs and facilitates monitoring depends on the duration of the relationship (it takes time to coordinate one's activities); long-term contracts allow both partners the benefits of a learning curve;
- Long-term partnerships will motivate suppliers to charge fair or even relatively low prices, and to deliver better-quality, low-cost products and services.

As a result of the above argument we may conclude that IT investments will cause a shift towards more long-term relationships between buyers and sellers (Clemons *et al*., 1993).

Relationship specificity

Long-term relationships enable investments in specific assets, which support the value exchange. *Asset specificity* of a transaction, a key concept in TCE, refers to the degree to which a transaction needs to be supported by transaction-specific assets (Douma & Schreuder, 1998). Assets are specific to a transaction if they cannot be used otherwise or elsewhere without incurring a significant reduction of value. The more transaction specific the investment, the greater the difference between the value of the investment in the current transaction and the value of the investment in other transactions (Barney & Ouchi, 1986). Examples of asset specificity are *physical asset specificity* and *human capital specificity*. *Physical asset specificity* occurs when one or both parties invest in equipment that can only be used for this transaction, and that has a low value for alternative uses; *human capital specificity* refers to employees developing skills that are specific to a particular transaction.

In TCE, the unit of analysis is the transaction; it analyses each transaction separately to predict whether it will be organised across a market or within a hierarchy (Barney & Ouchi, 1986). Our analysis differs as it principally focuses on IOS-related resources to facilitate IOR. Analysed from a relationship perspective, *transaction-specific assets* may be valuable to other transactions within the same relationship. *Relation-specific assets* are tailored to a particular business partner and have an idiosyncratic nature; they may be important sources of value creation and cannot easily be redeployed outside the relationship. A resource is perceived to have a higher degree of *relationship specificity* if it has lesser value when it is redeployed in alternative relationships (Subramani, 2004; Ibrahim & Ribbers, 2009). Subramani (2004) analysis resources within IOR and asserts that relationship-specific investments can improve strategic relationships.

RBV

From the RBV, each organisation is perceived as a bundle of resources emphasising the heterogeneity between organisations originating from different resources and different mechanisms of combining resources (Wernerfelt, 1984). Penrose (1959) argues that an organisation 'is basically a collection of resources' and accordingly, the diversity between organisations results from combinations of various resources and the speed of accumulating resources. Wernerfelt (1984) argues that resource position barriers, such as imitation barriers, can produce above normal returns influencing the competitiveness of the organisation. Later studies focus on various resource characteristics that lead to competitive advantage (Amit & Schoemaker, 1993; Dovev, 2002).

Barney advances the theory by identifying the required characteristics of resources to create sustainable competitive advantage. He argued that such resources are valuable, rare, inimitable and non-substitutable (Barney, 1991). Other studies adopt and expand Barney's theory to include other resource characteristics such as resource durability, non-tradability and idiosyncratic nature of resources (Grant, 1991; Collis & Montgomery 1995; Powell & Dent-Micallef, 1997; Venkataraman, 1997). Grant (1991) distinguishes between resources and

capabilities. Resources are basically inputs into the production process and capabilities are organisation-specific information-based processes that are developed through interactions among resources. Organisations with high IT capabilities are likely to outperform competitors on a variety of profit- and cost-based performance measures (Bharadwaj, 2000). Teece *et al*. (1997) emphasise the influences of knowledge resource to realise strategic advantage and highlights path dependence contending that previous investments constrain current and future behaviour and opportunities for learning.

Within the information systems field, the resource-based perspective is utilised to distinguish different types of IT resources and capabilities. Bharadwaj (2000) classifies IT-based resources into three types including (1) physical infrastructure; (2) human IT resources including technical and managerial IT skills; and (3) intangible IT-enabled resources including knowledge assets and synergies enabled by IT. Whereas the importance of physical IT resources has been questioned (Carr, 2003), the importance of human-based resources has been highlighted by various studies. Mata *et al*. (1995), Powell & Dent-Micallef (1997) and Ritter & Gemunden (2003) argue that top management commitment and organisation of IT are valuable organisation-specific resources. These resources can produce competitive advantages when they are complemented with suitable human resources such as IT skills and organisational culture encouraging change and experimentation.

THE EFFECTS OF HUMAN KNOWLEDGE RESOURCES

Grant (1991) and Bharadwaj (2000) utilise RBV to argue that when an organisation combines various resources, it can develop organisation-specific information-based capabilities that enable improved performance. For example, the human ability to perceive and learn new innovations combined with agile IT infrastructure becomes an important organisational capability to adapt to the changing competitive environment. Subramani (2004) and Malhotra *et al*. (2005) analyse IOR and assert that relationship-specific investments can lead to important strategic relationships. By applying the logic of the RBV to IOR, we argue that human-knowledge resources play a key role in the development and existence of IOS capabilities and achieving strategic benefits. Human-knowledge resources comprise IT and business knowledge that is possessed by human agents and utilised to communicate with the business partner. Such knowledge is viewed as a dynamic and ongoing social accomplishment and not as an external substance (Orlikowski & Baroudi, 1991).

IOS capabilities are at the relationship level and include abilities and competencies developed through the use of the IOS. We distinguish between process-based and knowledge-based IOS capabilities. Process-based IOS capabilities encompass the interlinkage of business processes across organisational boundaries. Relationship-specific human knowledge is important for successful process interlinkage as it enables a common view and improves the ability to coordinate actions. Sharing knowledge enables more rapid and effective reactions to emerging possibilities in the environment. When human agents sense market changes, they can utilise all available knowledge, including partner-specific knowledge, to

improve processes and exploit opportunities within the new market conditions. This is exemplified in just-in-time delivery settings where managerial supervision is essential for execution and improvement of processes.

Knowledge-based IOS capabilities encompass the transfer and sharing knowledge across organisations using IOS. Relationship-specific human knowledge enables effective information exchange because each organisation knows the abilities of the partner and how to utilise these abilities effectively. Combined with such knowledge, IOS can facilitate rich information exchange to improve interorganisational research and development and to enhance product development across organisations and create new business opportunities for both business partners. The IOS can be used to coordinate internal organisational developments in real time and to communicate specific market trends within the hypercompetitive business environment. Furthermore, in case of tacit knowledge, the IOS can facilitate access to knowledge by locating individuals with appropriate expertise and it can improve communication between those individuals. Hence:

H1a: Human-knowledge resources that have a high degree of relationship-specificity positively affect process-based IOS capabilities.

H1b: Human-knowledge resources that have a high degree of relationship-specificity positively affect knowledge-based IOS capabilities.

Knowledge-based IOS capabilities improve knowledge sharing and such capabilities are expected to have two imperative influences: improve process-based IOS capabilities and attainment of strategic benefits. On the one hand, sharing knowledge across organisational boundaries can positively influence effectiveness and efficiency of cross-organisational processes. Acquiring access to knowledge of partner organisation increases the opportunity of detecting novel knowledge (Nooteboom, 2004). This can provide various opportunities to optimise processes and enhance the connectivity between internal and external activities. On the other hand, successful sharing of knowledge may positively influence the attainment of strategic benefits. Organisations utilise their partners' knowledge to increase their understanding of the market, to have access to a broader range of opportunities and to able to conduct enhanced decision-making. Partners share market information and combine their skills to develop new products and services that provide a competitive advantage.

H2a: Knowledge-based IOS capabilities positively affect process-based IOS capabilities.

H2b: Knowledge-based IOS capabilities positively affect the attainment of strategic benefits.

An IOR at the operational level can be perceived as one organisation providing products or services to a business partner in exchange for compensation. Numerous IOS are focused on the improvement of information flow across organisational boundaries to achieve operational benefits including cost reduction, data error elimination, customer responsiveness improvement, efficiency gains, product quality monitoring and automation of boundary-crossing processes (Cash & Konsynski, 1985; Subramani, 2002; Buxmann *et al*., 2004). Organisations utilise electronic communication to increase the efficiency and effectiveness of business

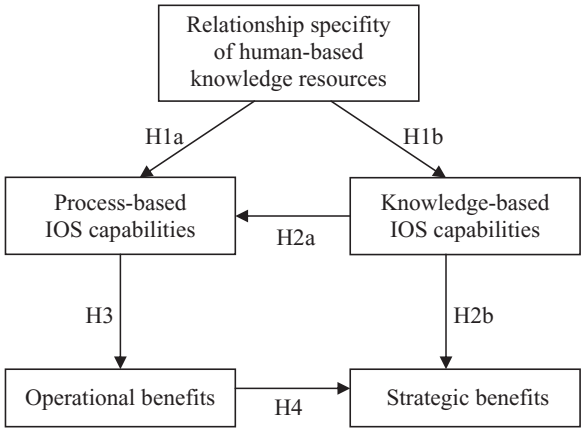

Figure 1. Conceptual model.

processes. Business partners using IOS to realise smooth communication are better able to react to latest changes, coordinate activities and achieve higher performance. Hence:

H3: Process-based IOS capabilities positively affect the attainment of operational benefits.

Accumulation of various operational benefits leads to the attainment of strategic benefits. Operational benefits can be realised in various aspects such as the reduction in costs, improved processing of orders or more efficient stock management. The accumulation of these aspects and their convergence is expected to lead to attainment of more strategic benefits such as better understanding of customer needs and increased competitive advantage for the business partners (Figure 1).

H4: The attainment of operational benefits positively affects the attainment of strategic benefits.

THE EMPIRICAL STUDY

This study adopts the triangulation principle (Webb *et al*., 1966) and uses two types of triangulation: method triangulation and data triangulation. Method triangulation is realised by following a mixed method approach with the objective to double-checking results. Combining multiple qualitative case studies and a quantitative field study enables more rigorous testing of the hypotheses (Attewell & Rule, 1991). Quantitative evidence can save the researcher from being influenced by vivid, but incorrect, notions in qualitative data. Qualitative evidence is valuable for discovering the rationale triggering the relationships revealed by the quantitative data. Data triangulation is realised by gathering data through a variety of data sources within the case studies. Data sources include semi-structured interviews, organisational documents and published information.

The unit of analysis of both methods is the dyadic business relationship between two organisations. The organisations are separate, legally independent organisations and they can take decisions autonomously regarding their relationship with their environment.

Measurements

The items used to operationalise the constructs are from existing studies. The relationship specificity of human-knowledge resources is determined through evaluating business knowledge and IT knowledge required to communicate with the business partner (Subramani & Venkatraman, 2003). The items used to determine process-based IOS capabilities include ability of the IOS to support order processing, exchange of shipment information, integration of order planning and coordination of responses to unexpected disruptions (Subramani & Venkatraman, 2003). Knowledge-based IOS capabilities involve ability of the IOS to improve expertise, create new business opportunities, understand market developments and integrate functions between business partners (Subramani & Henderson, 1999; Subramani & Venkatraman, 2003). Operational and strategic benefits are adapted from Sriram *et al*. (2000). Operational benefits include lower transaction costs, improving cash flow, more efficient stock management, higher productivity and faster processing of orders. Strategic benefits include improving competitive advantage, improving the relationship with customers and understanding their needs, improving information exchange with business partners and improving products and services.

Case studies

Case studies are useful for in-depth investigation of contemporary events and phenomena within their natural settings (Benbasat *et al*., 1987; Yin, 2003). Besides testing the hypotheses, the aim of multiple case studies is to acquire more insights into the proposed causal links. This study adopts theoretical replication by designing multiple case studies to cover different theoretical conditions with the objective of producing contrasting results for predictable reasons (Yin, 2003). Relationship specificity of human-knowledge resources is the only independent variable that is not influenced by other variables within this study. Accordingly, we conducted initial interviews with a number of organisations to assess their suitability and selected two cases with distinct degrees of relationship specificity of human-knowledge resources. Case A is characterised with high relationship specificity of human-knowledge resources and case B is characterised with low relationship specificity of human-knowledge resources.

Case A: the relationship between global automation companion and trundac logistics

Global Automation Companion (GAC) is a globally operating industrial automation company based in the US. GAC supplies a broad product portfolio related to industrial automation products, systems and services. Its sales exceed $3.5 billion and occur through a blend of direct sales, sales through distributors and system integrators. The case study focuses on the

relationship between GAC and Trundac Logistics. Trundac manages the storage process of products designated for Europe, Middle East and Africa (EMEA). Trundac is a subsidiary of a Dutch logistics group of companies. The services of Trundac mainly include the integration of different types of carriage, logistics and value chain services. The intensive collaborations were started approximately 10 years before conducting this case study with an extensive 5-year investment contract, which specified that GAC has to build a dedicated warehouse and Trundac would provide the personnel to operate the warehouse.

Communication between GAC and Trundac is conducted through multiple EDI connections. Service orders of GAC EMEA are transferred to GAC US and then to Trundac. Trundac performs orders and sends confirmations to GAC US. Communication passes through GAC headquarters in the US because products stored in the warehouse are property of GAC US and stock modifications need to be processed by their financial systems due to accounting regulations of Sarbanes-Oxley.

GAC and Trundac utilise relationship-specific human-knowledge resources to realise the automated interorganisational exchange of information. The setting of the relationship requires representatives of both organisations to conduct frequent meetings and share comprehensive information concerning their internal procedures related to the relationship. These meetings allow accumulation of insights specific to the interorganisational activities between GAC and Trundac. Human agents of both organisations thus acquire substantial relationship-specific knowledge resources concerning internal activities and procedure of the partner organisation. These resources enable correct execution of orders under various market conditions. This is exemplified in the cross-dock project that GAC initiated aiming at decreasing the minimum stocking period of products after arrival from 48 to 24 hours. As all changes in the inventory should be updated in all major systems of both organisations, the project required the collaboration of logistic executives and IT experts on both sides. This resulted in increasing the relationship specificity of human-knowledge resources. Furthermore, the frequent meetings also provide managers an inside view on the strategic plans of the partner. Such sensitive information can help managers to safeguard their efforts and resource investments from abrupt cancellation of strategic activities.

Electronic communication between GAC and Trundac enables various IOS capabilities including interlinkage of business processes and transfer of information and knowledge. The IOS facilitates the process-based IOS capabilities that are essential for conducting daily operations. When GAC sales agents confirm sales orders with a customer, GAC issues pick orders to Trundac to prepare products for shipment. As Trundac prepares products, GAC issues shipment to another transport organisation; most products should be ready for shipment within 4 hours after confirming sales orders with the customers. As there are more than 1000 orders daily, interruptions can have significant influences and accordingly, specific cross-organisational procedures are designed for such cases. In case of interruptions, employees of Trundac immediately discuss specific details with GAC, including all items being picked up, quantities and exact time. Communication is easier because of the close proximity of employees. We observed that GAC and Trundac employees share the same building and are easily accessible for formal and informal discussions. This intense collaboration is possible because

of the tight coordination between internal processes of both partners. Accordingly, we argue that GAC and Trundac have developed process-based IOS capabilities within the IOR.

Using the IOS to exchange information and knowledge between both organisations also enables knowledge-based IOS capabilities. The first capability of using the IOS is exchanging extensive information regarding past market trends and future forecasts. As GAC serves a volatile market, the IOS also perform various types of market analyses and communicate the results of these analyses to both partners. GAC is limited in some of its activities by the capacity of Trundac. Accordingly, the IOS enables GAC to have detailed information regarding Trundac's abilities and the required planning to cope with the market changes. Trundac benefits as it acquires accurate future forecasts and can deploy its resources more efficiently. The second IOS capability is realising tight coupling between organisations to enable further improvement of the relationship. Transfer of in-depth knowledge in a secured and reliable fashion enables organisations to effectively design and plan modifications of cross-organisational processes. The cross-dock project discussed earlier is an example of the need of having detailed information of both business and IT-related issues in order to realise modifications.

The IOS capabilities facilitate operational and strategic benefits for both GAC and Trundac. Operational benefits include lower transaction costs realised through meeting accurate forecasts and progressive cost targets. Strategic benefits include enhancing GAC's customer satisfaction by realising reliable and fast deliveries. The consistently high performance of GAC has also improved its reputation as a reliable supplier within the volatile market it is operating in. For Trundac, the satisfaction of its customer, that is GAC, is of prime importance. These benefits have eventually led to prolongation of the relationship and extension of the contract.

Case B: the relationship of Fretadia with Phoselot

Fretadia specialises in designing and manufacturing stylish home and bathroom accessories. It is based in the Netherlands and has production facilities in Hong Kong. Fretadia's yearly revenues exceed 1 million euros and its customers consist mainly of retailers specialised in upscale stylish products. The case study focuses on the relationship of Fretadia with Phoselot. Phoselot has been a customer of Fretadia for the past 4 years. Phoselot operates several types of large discount stores and department stores in North America and its yearly revenue exceeds $40 billion. Phoselot procures products from a large number of suppliers and demands from them to comply with regulations prescribed by authorities as well as additional rules and audits to ensure compliance to higher standards, which Phoselot prides itself with.

Communication is conducted through an extranet that Phoselot has developed to facilitate interactions with its numerous suppliers. The system is linked with Phoselot's enterprise resource planning (ERP) system and provides plentiful up-to-date information and performance metrics including stock levels, data on damaged products and various future predictions. Phoselot also uses the system to perform annual reverse auctions to purchase

commodity products. Phoselot determines most of the contract terms in advance and accordingly, the main selection criterion is price.

The relationship specificity of human-knowledge resources is low as human knowledge is not specific to Phoselot. Fretadia's managers evaluate standard contracts offered by Phoselot to many of their suppliers. Furthermore, the nature of products does not require specific domain knowledge. Accordingly, managers of Fretadia do not need in-depth information to maintain the relationship with Phoselot. They acquire information regarding prices of raw materials and manufacturing costs from public sources and try to place competitive bids at the reverse auctions. Even after signing contracts, there is no need for frequent meetings between representatives as the extranet transfers explicit codified information without loss of integrity. The system is easy to use and Phoselot provides support in case of technical problems. Accordingly, human-knowledge resources are characterised with low relationship specificity.

Interorganisational communications between Fretadia and Phoselot are not enabling IOS capabilities. There is a long time span between ordering and final delivery. Orders are issued weekly and products are typically manufactured within 2 weeks and delivered to Phoselot's agent in Hong Kong. Products are subsequently shipped to the US ports and are delivered approximately 4 weeks later. The long time span between ordering and delivery implies that short-term market fluctuations have to be absorbed by maintaining a buffer stock. Furthermore, business processes are not interlinked across organisational borders and neither Phoselot nor Fretadia access information regarding internal processes of each other. Accordingly, we argue that no process-based IOS capabilities exist within the relationship. Furthermore, the stylish home and bathroom accessories are commodities and therefore, usually, no significant changes occur to the products after contracts have been fixed. Phoselot and Fretadia utilise the IOS to communicate large amounts of transaction and coordination information. This information exchange does not improve knowledge because the information is not utilised for any enduring objectives. Most communicated information originates from Phoselot's ERP and consists of information concerning inventory levels, historical data and forecasts. The business partners do not conduct further analysis to extract knowledge from that information. Therefore, it is argued that no knowledge-based IOS capabilities exist within the relationship.

The benefits obtained from the relationship through the use of the IOS are only operational. The IOS is used to facilitate exchange of large amounts of operational information to improve stock management and increase the speed of ordering and processing. However, ample information exchange does not result in the attainment of strategic benefits such as better understanding of end-customer preferences because no further analysis is conducted on the data.

The findings of both case studies are summarised in Table 1.

Field study

A web survey is used to contact and collect data from respondents representing internet shops based in the Netherlands and selling computer-related products. The questionnaire

Table 1. Summary of case study findings

	Case A GAC and Trundac logistics	Case B Fretadia and Phoselot
Relationship-specificity of human knowledge resources	High	Low
Process-based IOS capabilities	Existing	Non-existing
Knowledge-based IOS capabilities	Existing	Non-existing
Operational benefits	High	High
Strategic benefits	High	Low

GAC, Global Automation Companion; IOS, interorganisational systems.

focuses on their relationships with their transportation companies. For internet shops, relationships with transportation companies are important because products need to be delivered to customers in a timely and proficient manner. Some products require last-minute modifications according to customer needs or on-site installation at customer's location. These relationships are attractive for this study because of the extensive reliance on information and communication technology (ICT) and need for timely and reliable information. More specifically, effective and intensive interorganisational communication is important for the performance of these companies. Therefore, we examine their investments in relationship-specific human-knowledge resources to attain improved IOS capabilities and performance. The Dutch transportation industry provides additional opportunity for this study because of the geographical location of the Netherlands in facilitating transportation and distribution to the European mainland, and because of the increased reliance on ICT to achieve timely communication across long distances. To ensure content validity, Lawshe's (1975) quantitative approach is employed by asking a panel including ten experts in the transportation industry to indicate whether or not a measurement item in a set of other measurement items is 'essential' to measure each theoretical construct. Subsequently, a pretest is conducted on 20 companies to observe the reactions of respondents to the questionnaire under realistic conditions. We discussed the questionnaire with some of the pretest respondents. The pretest led to minor changes in wording of the questions and sequence of the questions. To increase response rate, companies are offered to fill out a separate form to obtain a summary of the findings and to receive a benchmark of their answers with those from the entire sample. The number of valid responses is 137 (5% response rate). Our sample mainly consists of small companies: 85.4% have fewer than 10 employees. For the most part, they sell personal computers (PCs)/laptops (65.7%), PC spare parts/components (67.9%), software (60.6%) and PDAs and handhelds (54.0%). The transport is mainly conducted by road (97.8%), and the mean duration of the relation with the transportation company is 3.9 years. We do not pretend to have a representative sample of all Internet shops in the Netherlands (such a population is both ill-defined and very volatile), but there is no reason to assume that our respondents deviate from the majority of internet shops.

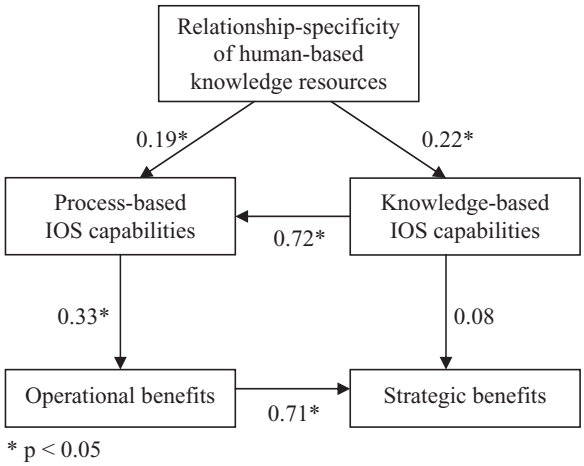

Figure 2. Standardised LISREL solution.

Structural equation modelling is used for data analysis as it enables validating the model in a single and systematic comprehensive analysis by modelling the relationships among multiple related equations simultaneously (Gefen *et al*., 2000). Linear Structural Relations (LISREL) is used as an structural equation modelling technique and it consists of two parts: the measurement model and the structural equation model (SEM). The measurement model identifies the relations between the observed measures, namely indicators, and their underlying latent constructs. The SEM identifies the causal relations between the constructs as put forward by the underlying theory. LISREL provides the opportunity to calculate the maximum likelihood estimates for both the measurement model and the SEM simultaneously. However, it is recommended that the measurement model is calculated and fixed before the structural model is estimated (Gerbing & Anderson, 1988; Gefen *et al*., 2003). Our study follows this two-stage approach.

The aim of the first step is to establish the convergent and discriminant validity of the constructs. This is done by developing a measurement model using LISREL confirmatory factor analysis (CFA). The measurement model is revised by dropping items that shared a high degree of residual variance with other items (Gefen *et al*., 2000). The CFA shows acceptable model fit. The χ^2 of 140.80 with 94 degrees of freedom is a χ^2 to degrees of freedom ratio of less than the recommended 1:3. The adjusted goodness of fit index (AGFI) at 0.83, the comparative fit index (CFI) at 0.95, the root mean square residual (RMR) at 0.047, and the root mean square error of approximation (RMSEA) at 0.061 are all within acceptable limits for CFA; the GFI at 0.89 and the normed fit index (NFI) at 0.89 are slightly below the 0.9 thresholds. Next, all hypothesised propositions are simultaneously tested by means of examining the structural model. The fit measures are acceptable: χ^2 to degrees of freedom ratio of 1:1.36 ($\chi^2_{109} = 148.61$), The AGFI at 0.85, the CFI at 0.96, the RMR at 0.067, and the RMSEA at 0.052 are within acceptable limits; the GFI at 0.88 and NFI at 0.89 are slightly below the recommended thresholds. Figure 2 shows the standardised LISREL path coefficients.

Results

The empirical data show support for both Hypotheses 1a and 1b. In both case studies and in the field study, high relationship-specificity of human-knowledge resources supports the existence of process-based and knowledge-based IOS capabilities. Hence, relationship-specific human knowledge facilitates successful execution of orders and successful transfer of information. The empirical data also show support for Hypothesis 2a: knowledge-based IOS capabilities support the existence of process-based IOS capabilities. The sharing of information and knowledge is thus found to support successful interlinkage of business processes.

The empirical data do not show undisputed support for Hypotheses 2b, 3 and 4. Case study findings show that knowledge-based IOS capabilities positively influence attainment of strategic benefits, but field study data show insignificant support for that influence. Taking a closer look at the relation between knowledge-based IOS capabilities and strategic benefits, we see in Table 2 a (significant) correlation of 0.26 between these constructs. This connection also appears in both case studies. However, counting with the indirect influence of knowledge-based IOS capabilities on strategic benefits (via process-based IOS capabilities and operational benefits, reflected in H2a, H3 and H4) we see that the direct influence almost vanishes. So we may argue that there is an influence of knowledge-based IOS capabilities on strategic benefits, but not a direct one. This fact can be seen from our field study, but not from our case studies; in the latter, we can only establish a causal effect, but we can not distinguish between direct and indirect effects. These findings argue in favour of our multi-method approach.

The case study on the relationship between GAC and Trundac logistics and the field study provide support for Hypotheses 3 and 4. Successful interlinkage of business processes is found to support attainment of operational benefits and subsequently the operational benefits coincide with the existence of strategic benefits. However, case study data on the relationship between Fretadia and Phoselot show that even though when process-based IOS capabilities do not exist, operational benefits can be obtained. It can be argued that in that particular case, the operational benefits are obtained through other activities. Moreover, the operational benefits in that particular relationship do not lead to the attainment of strategic benefits. These findings are summarised in Table 3.

Table 2. LISREL standardised correlation matrix

	Human knowledge resources	Process-based IOS capabilities	Knowledge-based IOS capabilities	Operational benefits	Strategic benefits
Human knowledge resources	1.00				
Process-based IOS Capabilities	0.35	1.00			
Knowledge-based IOS Capabilities	0.22	0.77	1.00		
Operational benefits	0.11	0.33	0.25	1.00	
Strategic benefits	0.10	0.29	0.26	0.73	1.00

IOS, interorganisational systems.

Table 3. Summary of the empirical findings on the conceptual model

Hypothesis	Case A	Case B	Field study
1a	Supported	Supported	Supported
1b	Supported	Supported	Supported
2a	Supported	Supported	Supported
2b	Supported	Supported	Not supported
3	Supported	Not supported	Supported
4	Supported	Not supported	Supported

DISCUSSION

This study uses the RBV to establish a conceptual model that describes influences of human-knowledge resources on IOS capabilities and subsequent attainment of benefits. Findings indicate that human knowledge improves IOS capabilities and leads to strategic benefits through the attainment of operational benefits. Relationship-specific human knowledge is important for process-based IOS capabilities, as cross-organisational processes can be sensitive to environmental changes. Human agents are able to sense these changes and to communicate their experiences with their colleagues. Based on their knowledge and experience, human agents cooperate and choose the best course of action to deploy the IOS to manage cross-organisational business processes. An example of this cooperation is provided in the first case study where GAC and Trundac representatives had frequent meetings to streamline processes. Collaboration of logistic and IT experts of both sides was necessary to speed the delivery process and eliminate unnecessary stocking routines. Furthermore, a lack of cooperation coincides with low process-based IOS capabilities. In the second case, representatives of Fretadia and Phoselot did hold meetings and they did not have the objective of discussing internal processes. Accordingly, their cooperation did not produce process-based capabilities and they need stock buffers to absorb short-term market fluctuations.

The findings also indicate that human knowledge improves cross-organisational transfer of knowledge. Similar to previous studies (Roberts, 2000; Anand *et al*., 2010), it is found that in case of tacit knowledge, IOS aids human agents in locating knowledge, specifically identifying individuals possessing that knowledge, and in case of explicit knowledge, IOS aids human agents in communicating explicit information. For example, the IOS used by Fretadia and Phoselot is used to communicate large amounts of explicit transaction information. This did not increase the tacit knowledge transfer between these organisations.

The findings do not support the argument that knowledge-based IOS capabilities have direct positive influence on strategic benefits. This contradicts recent studies arguing that knowledge creation and transfer produce direct strategic benefits. Our study shows that knowledge-based IOS capabilities only produce strategic benefits when they positively support process-based IOS capabilities and lead to operational benefits. This is exemplified in the case of GAC and Trundac; sharing up-to-date information improves operational adjustments, such as stock management, to market developments and yield operational benefits. In the long run, effective

sharing and analysis of information yields competitive advantage through enhanced relationship with customers and understanding their needs. Finally, results also indicate that accumulation of operational benefits subsequently can lead to the attainment of strategic benefits, in other words knowledge-based IOS capabilities are not crucial for strategic benefits.

The conceptual model presented in this study aims at combining theoretical concepts of TCE, RBV and knowledge management to improve the understanding how IOS are used. This study focuses on human-knowledge resources and our claim is that relationship-specific human-knowledge resources are key to improved performance. Following TCE, it is argued that relationship-specificity of resources enable the creation of additional value within IOR. Even though the concept of relationship specificity stems from TCE, it emphasises heterogeneity and diversity of IOR. This coincides with RBV arguments of Penrose (1959) and Wernerfelt (1984) that different collections of resources influence performance and the relationship specificity –perceived as imitation barrier– is key to the attainment of above normal returns. However, this study also extends the application of their arguments to an interorganisational context. Furthermore, the attainment of strategic benefits through the attainment of operational benefits confirms the path-dependence characteristic highlighted in previous RBV studies.

CONCLUSION

Human cognitive and social skills are essential for the success of IOR. The objective of this study was to examine how human knowledge influences use of IOS and the consequent influences of IOS on performance. The presented conceptual model shows that relationship-specific human knowledge has positive influences on two particular cross-organisational activities – interlinkage of business-processes and transfer of knowledge – and subsequently these activities positively influence the attainment of operational and strategic benefits. The conceptual model supports the notion of complementarities between TCE and RBV. The empirical findings provide strong undisputed support for most of the hypotheses of the conceptual model; however, some hypotheses do not obtain undisputed empirical support.

This paper provides theoretical contributions to the literature on IOS and strategic management. The analysis combines RBV with TCE and shows that fundamental assumptions of RBV apply within interorganisational context. This enables the focus on human knowledge as a resource without the loss of generality; hence, conceptual model can be applied to different types of IOS. The findings also complement previous studies within the IOS literature and provide additional complementary insights. For instance, Subramani (2004) and Malhotra *et al*. (2005) emphasise the importance of IT infrastructures that enabled rich information and knowledge sharing. This paper complements this by arguing that human coordination and management are essential supplements for knowledge transfer. Human thinking and knowledge are important in discovering and capitalising the opportunities within the constantly changing environment. Furthermore, the literature on strategic alliance management focuses on strategic long-term cooperative arrangements between organisations and sharing of resources (Hitt *et al*., 2000; Ireland *et al*., 2002). Here, it is argued that relationship manage-

ment and, more specifically, relationship-specific knowledge plays an important role in the achievement of strategic benefits. This study also focuses on how strategic benefits are achieved. The examination of the causal relationship between IOS capabilities and strategic benefits complements earlier studies and provides a conceptualisation relying on the dynamic compliance with requirements of the environment through information exchange. Distinguishing between operational and strategic benefits enables more accurate analysis of influences. Mukhopadhyay & Kekre (2002) examine the influences of electronic integration on the operational and strategic level. This study provides a more detailed analysis by focusing on the relationship specificity of human-knowledge.

This study has several limitations that can serve as possible directions for future research. First, the findings are restricted by the research context, which focuses on dyadic IOR. Organisations participate in other types of relationships, such as networks, electronic markets, cartels, associations and interlocking boards of directors. Within these contexts, human knowledge can have distinctive influences. Our findings cannot be generalised to all types of IOR and future research can incorporate other types of relationships. Another limitation of this study is the sole focus on the influences of human-knowledge resources. Future research can include other types of resources including tangible IT resources and intangible IT-enabled resources (Bharadwaj, 2000). Finally, the positive relationship between operational and strategic benefits is not supported by all empirical data in this study. Longitudinal research designs can enable the attainment of more accurate insights in the influences of IOS capabilities on operational and strategic benefits.

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APPENDIX A. STANDARDISED ITEM LOADINGS

Item	Wording	All items	After dropping items
	Relationship-specificity human knowledge resources		
HRE1	Our employees and managers require specific IT knowledge to be able to communicate with the business partner	0.87	0.86
HRE2	Our employees and managers require specific business knowledge to be able to communicate with the business partner	0.68	0.69
	Process-based IOS capabilities		
PRC1	IT supports order processing, invoicing and settling accounts	0.46	Dropped
PRC2	IT supports exchange of shipment and delivery information	0.73	Dropped
PRC3	IT supports integration of order planning and forecasts	0.86	0.82
PRC4	IT supports coordinating responses in case of unexpected disruptions	0.83	0.88
	Knowledge-based IOS capabilities		
KNC1	IT supports the improvement of organisational expertise	0.65	Dropped
KNC2	IT supports the creation of new business opportunities	0.82	0.84
KNC3	IT supports improving the understanding of market developments	0.83	0.83
KNC4	IT supports the integration of functions with the business partner	0.84	0.83
	Operational benefits		
OPB1	Lowering transaction costs	0.80	0.80
OPB2	Improving cash flow	0.85	0.85
OPB3	More efficient stock management	0.82	0.82
OPB4	Higher productivity	0.85	0.85
OPB5	Faster processing of orders of your own customers / end customers	0.83	0.83
	Strategic benefits		
STB1	Establishing and/or improving the competitive advantage of your organisation	0.86	0.85
STB2	Improving your understanding of the customers' needs	0.84	0.84
STB3	Improving your relationship with your customers	0.85	0.87
STB4	Improving the information exchange with your business partner	0.84	0.85
STB5	Improving your products and services	0.68	Dropped

APPENDIX B. CORRELATION TABLES

	HRE1	HRE2	PRC1	PRC2	PRC3	PRC4	KNC1	KNC2	KNC3	KNC4	OPB1	OPB2	OPB3	OPB4	OPB5
HRE1	1														
HRE2	0.5947	1													
PRC1	0.0976	0.0193	1												
PRC2	0.3058	0.2839	0.5484	1											
PRC3	0.2156	0.1874	0.3612	0.6393	1										
PRC4	0.2590	0.2146	0.3277	0.5484	0.7212	1									
KNC1	0.2275	0.3058	0.1999	0.3508	0.4891	0.4932	1								
KNC2	0.1008	–.0302	0.2303	0.3083	0.5051	0.5816	0.4911	1							
KNC3	0.2429	0.1510	0.1873	0.4346	0.4914	0.5490	0.5431	0.7011	1						
KNC4	0.1840	0.1378	0.1910	0.4379	0.5722	0.5435	0.5498	0.6972	0.6898	1					
OPB1	0.2342	0.1963	0.3086	0.3408	0.1901	0.2719	0.3904	0.2046	0.2056	0.2554	1				
OPB2	0.1024	0.1570	0.2687	0.2663	0.2421	0.2642	0.3876	0.1917	0.3002	0.2885	0.7133	1			
OPB3	0.2452	0.2211	0.3713	0.3558	0.1600	0.1842	0.2901	0.1859	0.1939	0.2321	0.6723	0.6990	1		
OPB4	0.2292	0.1646	0.3149	0.3805	0.2197	0.2395	0.3051	0.2199	0.2263	0.2797	0.6500	0.7041	0.7093	1	
OPB5	0.2320	0.1811	0.1941	0.3174	0.1410	0.1806	0.2547	0.0848	0.1078	0.1419	0.6261	0.6954	0.6708	0.7426	1
STB1	0.3155	0.1822	0.3026	0.3178	0.1573	0.2038	0.3299	0.1626	0.2301	0.1820	0.6301	0.5755	0.5082	0.5443	0.6064
STB2	0.1714	0.0926	0.2764	0.2612	0.1289	0.2306	0.3076	0.2486	0.3091	0.2563	0.4270	0.4498	0.3800	0.3972	0.4480
STB3	0.1870	0.0950	0.2684	0.2773	0.1325	0.1538	0.1717	0.1483	0.2706	0.1997	0.5044	0.5691	0.4667	0.5265	0.5705
STB4	0.2299	0.1335	0.2741	0.3590	0.2462	0.2089	0.2593	0.1755	0.2089	0.1432	0.5662	0.4863	0.5404	0.5512	0.6001
STB5	0.2655	0.2174	0.2369	0.4082	0.4030	0.4290	0.4750	0.3633	0.4248	0.5124	0.5316	0.4923	0.4431	0.5285	0.4399

	STB1	STB2	STB3	STB4	STB5
STB1	1				
STB2	0.7267	1			
STB3	0.6942	0.7686	1		
STB4	0.7153	0.6828	0.7445	1	
STB5	0.6028	0.5939	0.5092	0.5133	1