INFLUENCE OF INTERPERSONAL RELATIONSHIPS ON SOFTWARE SUPPLY CHAIN INTEGRATION: A RESOURCE ORCHESTRATION PERSPECTIVE

Bill Wang, Yuanfei Kang, Paul Childerhouse
College of Sciences, Massey University, New Zealand
Email: b.wang1@massey.ac.nz, y.kang@massey.ac.nz

Abstract

Purpose – The purpose of this study is to explore the role of the interpersonal relationships (IPRs) on software supply chain integration (SSCI). In particular, our study investigates the role of the three dimensions of inter-personal relationships (IPR) on strategic alliances, information sharing, and process coordination.

Methodology/approach – The research employs an exploratory/investigational approach to multiple case studies and empirically investigates the effects of IPRs in software supply chain integration in New Zealand. The data were mainly collected through semi-structured interviews with management staff (strategy/sales/service managers) from relevant software suppliers (developers) and their customers. Archival data from the Internet and company documentations were also applied.

Findings – We determine that in SCI, the Internet environment facilitates personal communication while simultaneously alienating personal affection, and plays a neutral role in personal credibility. More importantly, these three dimensions of IPRs influence SCI in different ways, even though the effect of IPRs on SCI is indirect: personal affection acts as an initiator, and personal credibility works as a "gate-keeper" and strengthens the confidence of interactive partners, while personal communication, a facilitator, plays a more important role in SCI than personal affection and credibility.

Originality/value – This research contributes to a better understanding of the relationships between IPR and SSCI. Advocating the resource orchestration theory in SCI, the external resources of the Internet and internal, tacit IRRs resources need to be concerted to achieve capabilities of IPRs in order to capture efficient and effective SCI. Our study develops the individual level research in SCI to a further depth.

Managerial implications – Our research provides managers in supply chain relationships awareness of the importance of IPRs in software chains, as well as the characteristics of IPRs, in order to best utilize the available resources. In the age of the Internet, managers should synergize all three dimensions of IPRs' resources: (1) make efforts to cultivate personal affection to avoid the instinctive isolation the Internet brings; (2) attempt to accumulate positive personal credibility profiles; (3) focus more on the role of personal communication and retain physical contact in the SCI process in spite of, or even because of, the Internet.

Keywords Interpersonal relationships, supply chain integration, software supply chain, case study

Paper type Research paper

Introduction

Nowadays more and more products (e.g. smartphones, automobiles, and computers) and services (e.g. billing, banking, information systems) are increasingly software-based rather than exclusively reliant on traditional physical devices or humans (Fricker, 2012). The main reason is that the Internet has grown exceptionally quickly over the last two decades and spread into nearly all areas of business, including supply chain management (SCM) (Lancioni et al., 2000). The Internet has dramatically influenced SCM by providing an unprecedented web-based platform for the development of relationships (Graham & Hardaker, 2000), speeding up communication between trading partners, improving service levels, and thereby reducing costs (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Yao, 2015). Supply chain

integration (SCI) is regarded as an efficient and effective approach to improving the performance of SCs (Huo, 2012). Most extant SCI studies, however, focus on physical products at the firm level, to examine various supply chain relationships (ICRs) at the organizational level, such as trust, power, leadership, commitment, justice, and reciprocity (Huo, 2012; Yeung et al., 2009). This research tendency is understandable and logical, given that SCI is nominally the integration between companies of suppliers and customers (Flynn et al., 2010). However, these firm-level studies tend to overlook those critical SCI enablers at the individual-level (Gligor and Holcomb, 2013), because in practice, organizational integration is planned, implemented, and controlled by individuals themselves (Wang et al., 2016). Limited research has been conducted to investigate the role of interpersonal relationships (IPRs) in SCI, especially in software supply chain integration (SSCI), with the exception of a few studies that focused on human resource management, general staff training and awareness of SCM (Fawcett et al., 2014), and the roles of salespeople (Jia et al., 2014).

More recently, Gligor and Holcomb (2013) highlight roles and benefits of personal relationships in buyer-supplier interactions, and call for more research to develop a deeper understanding of behavioral complexities. Barnes et al (2015) have gone deeper into IPRs' conceptualization and suggested that IPR have three primary dimensions, which are personal affection, personal credibility, and personal communication. Further on, Wang et al (2016) have applied IPR concept into the field of supply chain integration (SCI) and conceptualized the relationship between IPRs, ICRs and SCI. Following this framework, the role of personal level attributes can be applied to underpin SCI through a mediating effect from organizational level relationships. Although valuable literature has explored the role of the Internet in supply chain management (SCM) (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Yao, 2015), there is still limited empirical evidence on how IPRs are developed to improve SSCI which is closely related to the Internet. An in-depth study of IPRs in SCI needs to consider different characteristics of three dimensions of IPRs affected by the Internet and Internet-related technology and applications. For instance, when personal communication becomes more and more convenient, efficient, and effective with hand-held devices (Negron & Hayes, 2016), the Internet affects personal affection immensely, by isolating personal physical interaction (Mahmoudi et al., 2014). Meanwhile, personal credibility can be easily perceived from the profiles of both companies and personal blogs publically available in the virtual world (Greenberg, 2013). Both the positive and negative influences of personal credibility cannot be ignored in the SCI process. Therefore, it is necessary to study the synthesising effect of the Internet on IPRs in SCI.

Resource orchestration theory suggests that companies can structure and bundle resources to build capabilities, then leverage those capabilities to gain on the competition and to achieve superior performance (Sirmon et al., 2007; Sirmon et al., 2011), instead of simply combining the resources together (Liu et al., 2016). Inter-personal and inter-organizational relationships are both resources, because they are valuable, rare, inimitable, and non-substitutable (Barney, 1991). The Internet can also be regarded as a kind of resource (Ochkov et al., 2015) from the perspective of resource orchestration theory while the Internet, as part of a firm's resource portfolio, may not necessarily meet the resource-based view criteria when acting alone (Wu et al., 2006). However, only limited contemporary SCM literature focuses on the orchestration and synergy of all these resources in SCI. Instead, most studies focus on examining the independent effects of the individual resources (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Wu et al., 2006). There is a need to empirically explore how to interrelate resources of IPRs between suppliers and customers to achieve a superior SCI (Liu et al., 2016). Resource orchestration theory explores breadth (across the scope of the firm), life cycle (at various stages of firm maturity), and depth (across levels of the firm) (Sirmon et al., 2011). Our study mainly focuses on the domain of depth to develop our research framework.

This study aims to explore the role of IPRs on SSCI. In particular, it focuses on the following two research questions. Firstly, what are the characteristics of IPRs in software SCI? Secondly, how do three dimensions of IPR influence SCI? This study contributes to SCI literature and practices.

Theoretical background

Software supply chain integration (SSCI)

SCI can be defined as: "*the alignment, linkage and coordination of people, processes, information, knowledge, and strategies across the supply chain between all points of contact and influence to facilitate*

the efficient and effective flows of material, money, information, and knowledge in response to customer needs" (Stevens and Johnson, 2016, p. 22).

Since SCI explores firm-level integration, SCI would involve integration of all partners across the supply chain (Stevens and Johnson, 2016). But in real practice, the integration of the entire supply chain is extremely difficult and very rare (Childerhouse et al., 2011). More often, SCI mainly explores internal integration (Hom et al., 2014; Williams et al., 2013) or external integration. Internal integration refers to "the degree to which a firm can structure its organizational practices, procedures and behaviors into collaborative, synchronized and manageable processes in order to fulfil customer requirements" (Zhao et al., 2011, p19). External integration includes integration with supplier and integration with customer (Flynn et al., 2010; Huo, 2012). However, complete SCI is required to achieve the ultimate goal of SCM: to create maximum value through services and products provided to end-customers (Wisner et al., 2016).

This popular classification clarifies the scope of SCI and focuses on improving the performance of the supply chain, including internal units of a focal firm and its suppliers and customers (Stevens and Johnson, 2016). It emphasizes the "*importance of conceptualizing SCI as a multidimensional construct to examine its effects on firm performance*" (Liu et al, 2016, p15). However, more weight is placed on the SCI contents regardless of whether the integration is internal or external. Liu et al (2016) conclude that SCI includes four key components: information integration, synchronized planning, operational coordination, and strategic partnership. Prajogo and Olhager (2012) address information integration and logistics integration while emphasizing long-term effects. Our study addresses strategic alliances, information integration, and process integration as three key SCI dimensions corresponding to strategic flow, information flow and process flow, respectively (Min, 2015; Zhao et al., 2011). Strategic alliances are characterized by conjoined thinking and decision-making (Pagell, 2004) as well as synchronized planning (Liu et al., 2016) focusing on long-term symbiotic effect (Prajogo and Olhager, 2012). Information integration refers to the sharing of key information in the course of supply chain processes to achieve real-time transmission and processing of information vital for supply chain decision making (Prajogo and Olhager, 2012). Process integration refers to the extent to which supply chain partners streamline and smooth the supply chain processes (Liu et al., 2016).

A supply chain can be a product chain or a service chain (Selviaridis and Norman, 2014; Wang et al., 2015). Nowadays, more and more products and services are becoming software-based (Fricker, 2012). However, there is limited research on supply chains in the software industry. Unlike physical products, software can be easily copied, shared, resold, or rented (Variant 2000), reproduced and distributed quickly at negligible cost, thus potentially achieving fantastic profit margins (Cusumano 2006). Furthermore, software suppliers can provide exclusive service for locked customers (Fricker, 2012). Software supply chains focus more on the direct dyadic relationships between supplier-developers and their customers (Kali and Carmal, 1995). On the other hand, in comparison with the traditional physical product business, software business has a feature of a high uncertainty both for its software products and business market: short product life cycles (Weng and McClurg, 2003), in addition to highly unpredictable and risky product-development processes (Xu and Brinkkemper, 2007). Thus, in order to attain competitive advantages for companies (Naranjo-Valencia et al., 2011), software supply chains must respond quickly to changing environments with great flexibility and sensitivity regarding the market (Basu & Wright, 2008). As a result, companies are more like to follow a strategy of agility to achieve SSCI. Therefore, software supply chains provide a more meaningful setting to explore SCI between software suppliers (developers) and customers in terms of strategic alliances, information sharing and process coordination.

Inter-personal relationships (IPRs)

SCI is examined primarily as an organizational level construct (Stevens and Johnson, 2016) with various studies empirically testing the influence of a range of inter-organizational relationship (IOR) factors, such as trust, power, leadership, communication, reciprocity, and commitment (Huo, 2012; Cao et al., 2015). However, SCI practices are planned, implemented, and controlled by individuals, especially those with key boundary-spanning responsibilities, such as purchasing officers, sales people, customer service staff, invoice and receipt clerks, as well as relationship managers (Jia et al., 2014). The alignment, linkage and coordination of these individuals between suppliers and customers are emphasized in SCI (Stevens and

Johnson, 2016), highlighting the importance of IPRs in SCI. Thus, SCI is regarded as the state-of-the-art of this field (Pagell, 2004).

Barnes et al (2015) propose that IPRs have three main dimensions, namely, personal affection, personal credibility, and personal communication. Among them, personal affection, as an internal and relational aspect of IPRs, is a reflection of individual's feelings and sentiments. As personal affection is human feelings or likings relating to an enduring and emotional commitment to other individuals (Lee and Dawes, 2005), an individual's personal affection can affect and be affected by the personality, character, knowledge, lifestyle, and likings of the other individual during SCI interactions. After developing personal affection, individuals in a business interaction can have a mutually empathetic understanding of and affection for each other (Leung et al., 2006), providing the flexibility needed to handle changing circumstances as well as creating a strong tie (Leung et al., 2005). Thus, personal affection can affect the attitude and behavior of the representatives of suppliers or customers, consequently being conducive to the progression of a more comprehensive strategic alliance, greater information sharing, and profound process coordination, especially at the formative stage of SCI. After the formative stage, the function of informal IPRs may be gradually replaced by more formal IORs (Ekanayake et al., 2015).

Personal credibility is also an intrinsic element of IPRs, but contains further meaningful information. Personal credibility is the trust and confidence an individual can inspire in the business over time, based on a strong performance and achievement record, responsibility, and loyalty in the business (Barnes et al., 2015; Wang et al., 2016). It is gradual and long process for the building-up of personal credibility. Because trust can be character-based and reliability-based (Bowersox et al., 2010), personal credibility too can correspondingly be character-based (e.g. related to personal honesty and philosophy), or reliability-based (e.g. willing to perform). Therefore, it can give confidence to the counter-partner's representatives, who are then open to investing time and efforts, to prepare for the alignment of strategies in both firms, to share if not volunteering information, and to coordinate the formative processes. This is because personal credibility can generate strong desires to continue the relationship (Luo, 2007). Compared to the more subjective personal affection, which is hard to pin down and is based on heuristics and instincts (Diener et al., 2003), personal credibility is more objective as it is based more on facts and data.

Personal communication is the main vehicle to exchange information and ideas with business partners, in order to achieve familiarity and mutual understanding (Pearce and Robinson, 2000). In comparison with personal affection and personal credibility, personal communication has more of the external attribute of IPRs (Wang et al., 2016). Personal communication enhances the feeling that promises and obligations can be delivered as agreed, thus achieving harmony in IPRs and IORs (Ring and Van de Ven, 1994). When communication is more open and personal, the richness of the communication would increase, resulting in enhancement of the inter-organizational relationship (Cousins et al., 2006). As a result, a higher level of personal communication will lead to greater longevity of IORs (Barnes et al., 2015), because personal communication can encourage business partners to understand the intentions, plans and potentially even the strategies of the other business partners, to share the right information of the process, and to facilitate the process by reducing risks and conflicts in the process.

Resource orchestration theory

We now draw upon resource orchestration theory, an extension of resource-based view, to provide a theoretical lens for our research. Following a resource-based view, the valuable, rare, inimitable, and non-substitutable assets and possessions can be regarded as strategic resources (Barney, 1991). The heterogeneously distributed "sticky" resources can "be stuck with" other resources and capabilities among companies, creating competition (Teece et al., 1997). These resources can be tangible (e.g. equipment, employees) or intangible (e.g. services, knowledge) (Liu et al., 2016). Compared with other types of resources, IPRs – the intangible relationships between suppliers and customers at a personal level – are dearer because IPRs are more difficult to obtain and are more inimitable than more physically tangible resources. Moreover, as a type of resource, IPRs are full of dynamic, as they are assembled within different time horizons (Ketchen et al., 2014).

However, possession of abundant resources by itself does not "indicate how resources can be deployed to generate synergistic effects" (Liu et al., 2016, p. 14). Resource orchestration theory states that a company's resources need to be structured and bundled to build capabilities, then be leveraged to achieve superior performance (Sirmon et al., 2007; Sirmon et al., 2011) rather than to be merely combined together (Liu et al., 2016). How to manage the resources to make full use of their potential may be just as important as which resources a company posseeses (Ketchen et al., 2014). More importantly, the fit or alignment of interdependent resources should be considered (Liu et al., 2016). For instance, the Internet and related IT is widely regarded as a type of resource (Ochkov et al., 2015). However, the Internet, as part of a firm's resource portfolio, may not meet the resource-based view criteria for creating competitive advantage when acting alone (Wu et al., 2006), because of the relatively low barriers to imitation and acquisition by others.

This weakness can be effectively addressed by taking an analytic lens of the resource orchestration theory, as this theory is particularly useful for understanding the fit and deployment of resources and capabilities, such as IPRs, IORs, the Internet, and SCI. Based on this theory, when the Internet is structured, bundled with other resources such as company-based information technology and management systems, the Internet can be leveraged to gain competitiveness for the company. Because the supplier-customer boundary individuals have dual identities at both the personal and firm levels, the relationships between them are more complex when affected by the Internet. Thus, our study focuses on how companies leverage and orchestrate their resources in the forms of Internet and IPRs in order to achieve SCI at organizational level. More specifically, following the conceptualization of three dimensional IPRs as personal affection, personal credibility, and personal communication (Barnes et al., 2015), our study examines how these three dimensions of IPRs have played the role of SCI enablers. As a type of resources, IPRs include three dimensions which are rare, valuable, and very difficult to be imitated and substituted when employed in a firm (Barney, 1991) and can be regarded as resources of both firms and individuals. Each dimension has its own characteristics and functions in different ways, but the three dimensions are inherently related to each other and cannot be separated (Barnes et al., 2015). As a result, the three sub-resources of IPRs can be inherently orchestrated in different manners controlled by the relevant individuals. The resource orchestration theory can be applied in various research settings, such as breadth (across the scope of the firm), life cycle (at various stages of firm maturity), and depth (on different levels of the firm) (Sirmon et al., 2011). This study mainly focuses on the domain of depth, in terms of three dimensions of IPRs affected by the Internet, to extend resource orchestration theory and develop our research framework (Figure 1).

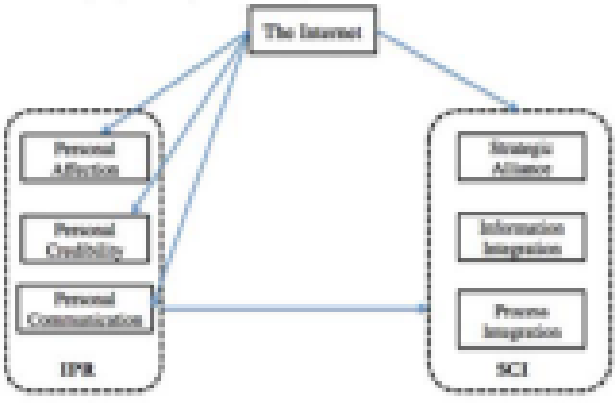

Figure 1. Research Framework

Research methodology

Through an exploratory case study, our research aims to explore the role by IPRs in enabling SCI in the Internet environment. Most prior research of SCI focuses on the firm level (Gligor and Holcomb, 2013) and studies different resources (for instance, the relationships, the Internet) in SCI independently (Bruque-Cámara et al., 2015; Lancioni et al., 2000; Wu et al., 2006). Methodologically, most prior research in SCI applies quantitative oriented method, such as questionnaire survey (e.g. Flynn et al., 2010; Huo, 2012), resulting in a lack of in-depth understanding regarding the dynamic nature of the

development and IPRs and their influence on SCI (Barnes et al., 2015; Gligor and Holcomb, 2013; Wang et al., 2016). Moreover, there is limited research on the synthesized influence of three dimensions of IPRs in SCI affected by the Internet. To address these research gaps in terms of research topic and methods, we employed an exploratory qualitative case study approach (Eisenhardt, 1989) in order to develop an in-depth understanding of the concerted effect of the three dimensions of IPRs and the Internet in SCI by observing actual practices (Voss et al., 2002). The in-depth case studies explore the linkages between IPRs changed by the Internet and SCI in real-world software supply chains.

Case selection

Case selection is a critical issue for a case-based study. As this study focuses on the role of IPRs in SCI in software chains affected by the Internet environment, we selected two case companies of software developers and focused on their supply chains. One is the supply chain of a case company named NIS, consisting of NIS (a leading local software developer in New Zealand and based in Wellington) and its foreign supplier, USM (a US-based world leading software and platform provider). NIS provides business and government clients with web-based solutions and services such as financial and client relationship management; custom software development and systems integration; web and digital strategy. It is a leading software developer and service provider in Australasian, employing 380 people in New Zealand, Australia, and North America. It can be a representative of large software company. NIS started to collaborate with USM as supply chain partner in 2001, and its supply chain strategy focuses more on supplier integration.

Another one is AKS supply chain, consisting of AKS (an Auckland-based software developer) and its customers. AKS focuses on providing its customers with IT solutions and services in the functional area of human resource management (HRM). It has 8 staff only and can be regarded as a small and medium enterprise (SME), just like 97% of business in New Zealand (Joyce, 2014). AKS strives for collaboration with its customers, so AKS chain focuses more on customer integration. Both NIS and AKS supply chains are embedding in the Internet environment: all their operations and processing, including software product development, service delivery, database maintenance and stock keeping, have been mainly conducted or involved in the Internet environment. The two companies have over five year's successful integration exposure with their suppliers or customers.

Data collection

Research instruments in this study include face-to-face and Skype semi-structured interviews lasting 60-90 minutes per interview and archival data from the Internet and company documents. The multiple sources of evidence strengthened the analysis by allowing triangulation on important issues to cross-verify insights and findings (Yin, 2003). Fieldwork of this research spanned for about eight months (from April to December 2016). To conduct the interviews, we used a three-part interview protocol (Appendix 1): (1) company and IPRs people profile; (2) SCI in the Internet; (3) Role of IPRs in SCI in the Internet. During the interviews we provided interviewees a list of three main aspects of SCI and nine roles and activities of IPRs in SCI in the Internet environment, drawn from literature review, and asked them to discuss each aspect and role from their experience, knowledge and understanding. We also asked them to identify aspects or roles not listed. Each interview started with a brief introduction about the research purpose. Then the interviewees were asked about their company background, main business, and their strategic supplier-customer relationships in terms of strategic alliance, information sharing, and process coordination. In regard to individual dyadic relationships, the respondents were asked how and why personal affection, personal credibility, and personal communication affect the organizational level relationship factors during different stages of their relationships. The interviews also explored the attitude and opinions if IPRs should be encouraged or not. We apply multiple respondents for each case to enhance validity (Yin, 2003) and reliability of the collected data (Voss et al., 2002). We purposely selected top, middle, and operational level staff such as managing directors, product managers, marketing managers, and sales representatives. Thus we acquired a range of hierarchical levels and greater depth and multiple perspectives: the top management have more comprehensive viewpoints about the role of IPRs in SCI while the middle level managers have more directly interaction experience and skills with supply chain network partners. The interviews were audio-recorded with the prior permission of the interviewees and subsequently transcribed. Unclear answers were clarified and supplemented through emails or follow-up telephone calls. The draft reports were reviewed by two researchers. We validated the

results by performing tests of validity and reliability. In terms of construct validity, we apply the multiple sources of evidence (interviews, archival data), multiple-level interviewees to complement each other. Internal validity has been enhanced according to the following suggestions (Merriam, 1998): (1) triangulating to confirm the emerging findings; (2) discussing the findings with research peers; (3) exchanging and communicating with interviewees on the data and interpretations; and (4) refining the theoretical orientation with our study. Meanwhile, comparing across the two case studies increases the external validity to examine the commonalities and differences. Reliability is less applicable to qualitative research (Merriam, 1998) as we concern more on the results' consistency with the data collected (i.e. interview notes, recording, transcripts, and interview questions).

The measures used for ensuring validity and reliability of the research throughout the case study are summarized in Table 1 (Gibbert et al., 2008; Yin, 2003).

Validity and reliability criteria	Case study tactics
Construct validity	Applying multiple sources of evidence to triangulate data (e.g. face-to-face and/or Skype interviews, information from the Internet, company documents) (Section 3.2) Establishing chain of evidence (e.g. the interview details, indication of data collection circumstances and clarification of data analysis approach (Section 3.2, and Section 4.2) The draft report was reviewed by three researchers (Section 3.2)
Internal validity	The case study was guided by a clear research framework (Figure 1) Applying pattern matching logic to compare the empirically identified patterns with the predicated patterns (Section 4.2)
External validity	Rationale for the case selection (Section 3.1) Details of the case study context (Section 4.1) The case study was guided by resource orchestration theory (Section 2.3)
Reliability	The interviews were guided by a semi-structured protocol (Appendix 1) We developed a case study database, including interview transcripts, notes, the Internet information, and companies documents (Section 3.2)

Table 1. Validity and reliability tests

Analysis and discussion

Case description

Since establishing in Wellington in 2001, NIS has been relying heavily on its supplier, USM, and has closely integrated with USM to develop, distribute web-based technologies and software products, IT solutions, and associated consulting services. NIS also works on projects from USM. It has been regarded as "Gold" member of USM Partner Network. NIS has been among the longest and largest dedicated providers of Microsoft-based solutions in the southern hemisphere and its Microsoft-related activity accounting for around 90% of its revenue. AKS, a typical SME in the IT industry, has developed a range of innovative workforce management systems since 2010, serving the New Zealand and Australian market. As a software developer, AKS specializes in providing solutions for time and attendance, employee and team scheduling, and payroll needs, as well as mobile solutions. AKS specializes in cloud-based time and attendance data management systems and operating in the business area with leading edge of technology innovation. It employed only 8 people but thanks to the successful achievement of integration with its customers and customer's network, AKS has attracted more than 100 customers in Australia and New Zealand.

Case analysis

All the interviewees quickly grasped the concepts in our research framework, such as IPRs, and SCI, at least in terms of practitioner comprehension. The two cases will now be explored in an attempt to set up a conceptual model.

The Internet, IPRs, and SSCI

Both NIS and AKS are embedded in the Internet environment to provide software products and service. NIS was located in the southern hemisphere while USM was located in the northern hemisphere with 19

hours' time differences between them. AKS and its customers doesn't have so much spatial and temporal discrepancy but AKS needs to collaborate with its tens of customers in Australasian area. It is the Internet rather than traditional physical and information flow technologies and approaches that make SCI possible. From inception, NIS contributes the integration achievement to strategic alliance and through joint actions

"We work closely with USM – both locally and globally – on the latest technologies, often well before these are unveiled to the wider world." (NIS)
"One thing above all has remained constant over our time in operations: our unwavering commitment to USM. Technology may have evolved radically over the years, but our core USM foundations have not (and will not)."
The partnership between NIS and USM is so successful that
"…USM operates, a lot of the products that are being developed, that we help them develop", "we probably know more about what's coming out of USM in the next five years than USM New Zealand does…"
AKS has similar experience:

"We work with our customers to understand their real needs…then we design the right solutions for them."

In terms of information sharing and integration of process, the Internet works as a timely and effective facilitator. To achieve integration with USM, NIS maintains high standards of information sharing/ security and process coordination with USM. *"It could be information control, confidentiality, keep a tight rein on things, because we have very heavy non disclosure agreements with Microsoft HQ."* Both case companies of software chain developers/suppliers transfer and exchange real time information and knowledge to their customers, such as company data, strategic plan, updated requirements, questions and answers, and solutions by using online communication applications (e.g. emails, Skype, video conference).

In both cases, the focal companies have been greatly benefitted from the modern information and communication technologies (ICT) to achieve SCI with their supply chain partners. However, our empirical data suggests that IPRs have played even more significant role to enable achievement of SCI. There are at least two reasons. One is that IPRs built up in the supply chains by the focal companies have facilitated their access to the latest technology and pace together with software partners (which will be explained in 4.2.2). The other reason is the side effects of the Internet and ICT on IPRs. For example, although emails improve communication efficiency, all the participants of interviews indicated that emails are "too *formal*" and "too *frosty*" and that over reliance on email could affect their "*friendships*" compared with traditional telephone calls. The online chatting makes more convenient "*communication with voice and expression*" but "*if you want to drink with them, you may be frustrated because they are far away*". Also, "*the Internet makes your personal and business information available, so, it will be good if you have good reputation, good experience, successful cases, of course, otherwise, it may make your case worse.*"

IPRs and SSCI
Both case studies attribute their SCI success to their people, especially IPRs. NIS addresses "*… the personal connection of our directors to USM has been the main basis of the relationship*". "*… we started off relatively small through a personal association with our director (of Strategy and Innovation), and over time it's expanded to be a large software business.*" The director is recognized internationally as a leader in his area of web technology, and his role is to provide a link between USM and NIS. NIS has developed and maintained good IPRs with USM not only at the top management but also at the lower levels. *"We've now got two people on the ground over there in the US, whereas in the past we were doing the work out of New Zealand." "By working closely with USM personnel on a daily basis, we stay connected"*. The main reason is "to make sure we're bringing the most up-to-date in thinking of USM, a global market leader" and to get "the earliest possible access to new technologies", also to "avoid the technical and financial risks associated with depending on a hot today, gone tomorrow technology"(NIS official website). "*…the guys that run that part of the business, they say it's not so much doing work for USM, it's doing work for about ten businesses within USM and a lot of it is based on personal relationships. For example, now we do the majority of their key note demonstrations at their large conferences … the ones that we've done work for over the years.*" Because of the good IPRs "built on numerous years of trust and mutual

cooperation", the relationship between NIS with USM "is more than just a nice-to-have credential". Furthermore, NIS extends the unique philosophy to other supply chain partners, for example, the business in Australia: "by staying personnel connected, we keep you connected". As a result, NIS states that "*(our) culture is based on our people: they are the key to our business. We employ people who are genuine, honest, seriously committed to what they do and, above all, talented.*"

The AKS case also provides a clear demonstration for the importance of IPRs in integration with customers. AKS has neither the time nor budget to invest into marketing. "*…all we have is our personal connections with potential customers. All our current customers are introduced by our friends, or friends' friends. It is very common and important for us to develop our market in New Zealand as it is a very small country and its culture is a little special.*" The IPRs were critical for AKS to develop its business, especially in the initial stages. "*…with the established personal relationships, our customers come to know our products and services in the beginning. Then, we can have a chance to learn the customers' time and attendance system; and most of their systems are time-consuming and laboring-intensive.*" AKS develops new customers through personal connections; then gains an appreciation of customers' requirements through information sharing before offering a customized solution; leading to the delivery of tailored products and associated service coordination "*according to pre-set company rules*". Through personal connection and network, AKS understand customers' situation and real needs, then convinces customers to collaborate to design customized solutions. Because each customer has its own requirements with different background, personal relationships become necessary and complementary during complex and sensitive data or information exchange process. Customers can save data in AKS cloud-based database to ensure information security. Also, customers can retrieve their data from anywhere at any time via the Internet. As a result, AKS' product and service has changed the customer's management approach and improved the overall efficiency. AKS has attracted over 100 customers across Australia and New Zealand.

There were also some interesting differences between the two cases. While NIS has committed its efforts to invest in IPRs throughout the whole process of supplier integration, the AKS case suggests that the role of IPRs is more important in the initial stage of SCI. As for the ongoing relationship, an executive of AKS stated that "*our products and service will do the job*". "*Of course, we will keep a regular personal touch with them to understand customers' new requirements, or to solve the problems from iTimer system application*".

Findings from the NIS and AKS cases also suggest that different dimensions of IPRs have different roles in facilitating SCI. In terms of strategic alliance, the role of personal affection is important, because "*Lots of customers start from talking and good feeling, especially for small companies.*" As for information sharing, personal affection seems to fall short. "*Personal affection is not significant, but it certainly makes for having the discussion about what information will be shared easier.*" (NIS). AKS disagreed with the role of personal affection in information sharing and simply said "No". Personal affection works a little better on process coordination as "*process coordination implies more ongoing personal interaction.*" (NIS). The interviewees indicated that personal affection is "*just kind of gatekeeper*" in regard to information exchange.

Personal credibility was seen more important than personal affection regarding to information sharing. Findings from the two case companies also demonstrated importance of personal communication. Compared with personal affection and personal credibility, personal communication is the more external attribute. Personal communication is the main approach to exchange the opinion and share the information to directly interact with business partners. In this way, personal communication can help in understanding the intention, plan and even strategy of the business partners, in obtaining the right information of the process, and in facilitating the SCI process by reducing risks and solving conflicts.

Evidence from our case interviews suggests that communications are more efficient and convenient with the help of web-based communication tools, such as Skype meetings and email in the Internet environment. On the other hand, our informants emphasized that traditional face-to-face contacts still works more effective and are preferred in quite some occasions.

Table 2 quotes the influence of personal affection, personal credibility, and personal communication on strategic alliance, information sharing, and process coordination.

	Strategic alliances	Information integration	Process integration
Personal affection	"We typically collaborate better with parties we have some liking of." (AKS). "We have shared many personal experiences and in doing so have reached a better mutual understanding of each other. We are now developing our ideas for the benefits of both businesses." (NIS).	"Personal affection is not significant, but it certainly makes for having the discussion about what information will be shared easier." (NIS). "No". (AKS)	"process coordination implies more ongoing personal interaction." (NIS). "just kind of gatekeeper" (AKS)
Personal credibility	"We are proud of and stand by our reputation. We employ some of the greatest Microsoft experts around." "Our experience reduces the risk to you, and helps increase the return on your technology investment". "We are not the cheapest but they (USM) must think they get good value for money, and we produce quality... We've never let them down." (NIS) "Definitely we like to do business with someone who we believe are credible". "Good personal credibility, means, the quality of trustworthy; for example, if you always keep your promise, I will trust you, then I would like to discuss the business." "For long term relationship, the personal credibility is the most important." (AKS)	"(our) exceptional technical community leaders share their high quality, real world expertise in offline and online technical communities around the world"; "more information will be forthcoming if a partner is seen as credible and capable for a long-term relationship." (NIS) "the role of personal credibility is limited – information sharing is something we agree between parties – we seldom associate or think about an individual's personal credibility in arranging or facilitating information sharing". (AKS)	"(our) experts are internationally recognised for our knowledge and experience in designing, creating, implementing and supporting Microsoft-based solutions." "We more readily will work with people we find personally credible to find solutions and supplier -customer process coordination is an example of needing to work together to find solutions".
Personal communication	"strategic alliance needs to be fed, and to feel that regularly meetings/chats/catch-ups are necessary." (NIS) "personal communication will strengthen the relationship and likely result in a mutually improved outcome." (AKS)	"impact of personal communication on information sharing seems even more significant"	"is helpful for a more harmonious integration of process between two parties."

Table 2. Observed significance of IPRs in SCI

Figure 2 shows the observed influence level of IPRs in SCI.

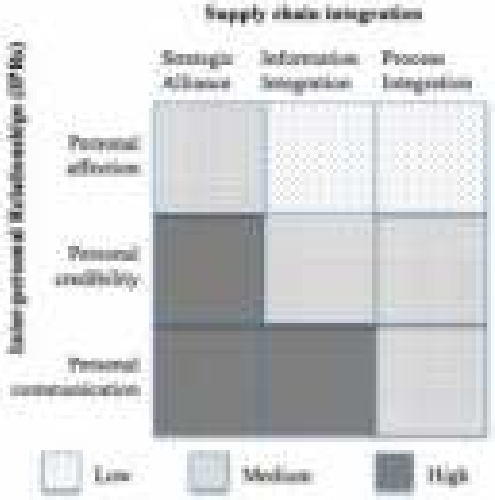

Figure 2. Observed influence of IPRs on SCI

Research proposition

The analysis indicates that IPRs can influence software supply chain integration (SSCI), although its influence on SCI is more likely to be indirect because IPRs must work through inter-organizational relationships (Wang et al., 2016). In software industry, every business customer needs a unique software solution because of differences in production procedure, organizational structure, and also available budget (Fricker, 2012). Thus, software developers or suppliers would need to provide tailor-made service for the locked customers. Our data also suggest that three dimensions of IPRs would influence SSCI differently in the dyadic integration between the direct supplier/developer and customer relationships (Kali and Carmel, 1995).

SSCI starts from strategic alliances to joined-up thinking, decision-making, and synchronized planning between a supplier and its customer (Liu et al., 2016; Pagell, 2004). It offers fast and flexible means of achieving market access, scale economies, and competence development (Larsson et al., 1998) and captures cross-business synergies to secure competitive advantage through collaboration (Narasimhan and Nair, 2005). However, the long-term collaboration strategic alliances between the supplier and customer (Prajogo and Olhager, 2012) starts from the interactions of relevant individuals. Personal affection, the intangible subjective resource, can affect the individuals' willingness and attitude (Leung et al., 2005) of whether or not to start the interaction after selecting and contacting a potential business partner's representative. Moreover, personal affection can provide the flexibility to manage changing market conditions and create strong tie between personnel of the supply chain partner (Leung et al., 2005). This flexibility is highly important for managing software supply chain activities. Because of high unpredictable and risky process as well as short life cycle of software product/system development (Weng and McClurg, 2003; Xu and Brinkkemper, 2007), software supply chain integration also has high uncertainty, which increases the uncertainty of subjective personal affection. Thus, software supply chain must response quickly with great flexibility to adapt to the changing market (Ron Basu and Wright, 2008). Because of the inner enduring and emotional commitment to others (Lee and Dawes, 2005), personal affection, the invisible human feelings or likings, can affect the willingness and attitude to further influence information sharing level, contents, frequency, and accuracy, as well as the knowledge transfer and exchange, software product development, delivery, and services during the process integration. Therefore, based on the above discussion, we propose that in the software supply chain:

P1a. Personal affection influences SCI as an initiator

Personal credibility refers to a person's quality to be trusted in the business (Barnes et al., 2015). It can be intrinsically character-based credibility or reliability-based credibility, corresponding to the classification

of character-based trust or reliability-based trust (Bowersox et al., 2010). Because software products are technology-intensive and knowledge-based (Lytras & de Pablos, 2011), only suppliers with professional and skilled experts can develop the requisite product and service systems. As a result, reliability-based personal credibility is the fundamental requirement in strategic alliance, information sharing, and process integration. Furthermore, it is highly unpredictable and risky to develop software products or systems in a high competitive market (Xu and Brinkkemper, 2007) and it needs long-term investment and effort. Therefore, without reliability-based personal credibility, the representatives of business partners would be difficult to develop trust and confidence during the SCI process (Luo, 2007). That is the reason our two software chain members convince customers or are convinced by suppliers by showing their successful experiences. Thus, personal credibility influences SCIs in two ways: good historical credibility resources in this industry can open the door for further interactions, while inferior credibility resources can instead hinder SCI. Therefore, we propose that in the software supply chain:

P1b. Personal credibility influences SCI as a gatekeeper

Because supplier-customer boundary individuals have dual identities at both personal and firm levels, open and frequent personal communication can lead to familiarity, mutual understanding (Pearce and Robinson, 2000), and harmony (Ring and Van de Ven, 1994) between individuals as well as supply chain partners. The dual identities of individuals can make the two level relationships to interact with each other, leading to greater longevity of inter-organizational relationships (Barnes et al., 2015). Personal communication, as a tool resource, can exchange information resources between suppliers and customers during integration process (Pearce and Robinson, 2000). Since software supply chain integration is undertaken in a highly risky, competitive, and costly environment (Ron Basu and Wright, 2008; Xu and Brinkkemper, 2007), personal communication can improve strategic alliances by investigating industry trends, understanding of developing strategy, selecting management information system, production and marketing plan. In terms of information integration, personal communication can exchange supplier's capability, customer's requirements, and software solutions proceeding. Regarding to process integration, personal communication can track the process, discuss questions, adjust developing schedules, and solve problems. Inter-organizational communication can promote strategic collaboration between firms (Paulraj et al., 2008). Compared with formal, bureaucratic, complex, time-consuming, and working time-confined organizational communication (Ashcraft, 2006; Diesner et al., 2005), personal communication can be more efficient and effective to facilitate SCI because it is more flexible, direct, and simple without strict time-confined. Thus we propose in software supply chain:

P1c. Personal communication influences SCI as a facilitator

Our case analysis indicates that the role of IPRs in SCI has been affected in the Internet environment. Personal affection is regarded as an important part of social tie (Morrison and Miller, 1999) and closely related to the personal interactions (Vaquera and Kao, 2006). The Internet, however, has extended informational and interactive capabilities, and served as functional alternative to the face-to-face interactions (Papacharissi and Rubin, 2000), thus the Internet has contributed to the increasing interpersonal isolation (Hampton et al, 2011) which affects the maintenance of personal affection. Personal affection accompanying with physical contact becomes luxury when individuals are alienated from each other (Hampton et al, 2011) when they rely on the Internet and related handset applications to achieve efficient and effective communication (Want et al., 2015). Meanwhile, the Internet provides abound personal profile information including personal background, position, responsibilities, and other historical experience and achievements and the related source credibility in the companies (Park et al, 2014). Because the personal profile information can be self-disclosed or disclosed in the Internet by the companies or supply chain network partners (e.g. customers) or even people themselves, the assessment of full personal credibility may take longer term (Greenberg et al, 2013). Furthermore, the disclosed personal credibility in the Internet can be both beneficial and risky: if a given entity's reputation is found to be excellent, a fruitful relationship is more likely to be formed than if that entity's reputation is found to be lacking. On the other hand, the Internet has provided new digital communication tools such as email, audio, and video software application in both computers and smartphones to facilitate the personal communication more efficiently and effectively (Want et al., 2015).

Therefore, we propose that in the software supply chain

P2a. The Internet has a negative influence on personal affection in SCI.
P2b. The Internet increases the visibility of personal credibility in SCI.
P2c. The Internet has a positive influence on personal communication in SCI.

Theoretical and practical implications

This research contributes to literature in two ways. First, prior research of supply chain integration mainly focuses on firm level relationship in terms of strategic alliance, information integration, and process integration, resulting in an overlook of SCI enablers at the individual level relationships (Gligor and Holcomb, 2013) and application-oriented research is rare. In addition, prior SCI research has mainly emphasized the popular physical supply chains, resulting in inadequate attention to software supply chains (Huo, 2012). Findings from our study contribute to the SCI literature by extending SCI from physical supply chains to software supply chains and investigating the mechanism of individual level relationships in SCI. Because software chains focus more on the direct dyadic supplier (developer) and locked customer linkages (Fricker, 2012), the individual level relationships play more significant roles in terms of strategic alliance, information sharing and process coordination. Also, our study compares the different roles of three dimensions of individual level's relationships, which complements the role of software product and service in SCI (Fricker, 2012).

Secondly, this study applies resource orchestration theory into SCI literatures in a deeper individual level. Most researchers apply resource-based view to study "what resources" a firm can use rather than "how" to deployed available resources to generate synergistic effects (Liu et al., 2016). Our study explores the characteristics of individual level relationship resources and the Internet resource embedded in software supply chains. We find that personal affection, personal credibility, and personal communication are inherently related to each other, but can be orchestrated purposely. In addition, the Internet resource also affects personal affection, credibility, and communication in different ways. Therefore, all these resources can be structured, bundled, and leveraged (Sirmon et al., 2007; Sirmon et al., 2011) to achieve superior performance in SSCI. Our study, thus, contributes resource orchestration theory in SCI in depth.

Our research also provides guidelines for managers in software supply chains to devise and apply inter-personal relationships practices to improve SCI with customers or/and suppliers. In particular, we suggest managers seriously aware the significance and characteristics of IPRs in software chains rather than rely on advanced technology and software products only. In this Internet times managers should understand the interactions and orchestration of all available resources then to make full of resources. Managers need to provide regular training in both technology and influence of new information and communication technology on people. More attention, efforts and time should be invested into developing and nurturing these relationships. Focus should be placed on individuals that enable these relationships, boundary spanners, rather than simply focusing on aggregate organizational level relationships. Also, managers should encourage more physical contact rather than online contact only with suppliers or customer, hence; we can cultivate personal affection to avoid the isolation effect from the Internet. Because of the gatekeeper role of personal credibility, managers should purposely select staff with good character-based personal credibility, also train staff to improve their reliability-based personal credibility based on their successful working experiences or cases, and carefully prepare and cumulate positive personal credibility profiles online. Considering the critical role of personal communication in SCI, personal communication skills should be cultivated based on training in order to keep frequent, direct, close personal communication in the SCI management process.

Furthermore, our findings also suggest that information and communication technology (ICT) tools are able to create more responsive business approaches in the Internet and mobile environment, but these ICT tools are secondary to personal contacts from a relationship perspective. Views from management executives and boundary spanners regarding the roles of ICT tools differ, depending on their positions within a company.

Conclusions, implications and future research

We have highlighted the role of IPRs on SSCI. The findings reveal that SCI facilitates personal communication, simultaneously alienates personal affection, and plays a neutral role on personal

credibility in the Internet environment. More importantly, although IPRs indirectly affect SCI, three dimensions of IPRs influence SCI differently: personal affection acts as an initiator, and personal credibility works as a "gate-keeper" to strengthen the confidence of interactive partners, while personal communication, a facilitator in SCI, plays more important role in SCI than personal affection and credibility.

Although this research makes significant theoretical and practical contributions, it has limitations that wait for future studies. First, this study uses exploratory case study approach and data were collected from two software supply chains in New Zealand. This cannot reflect the full picture of the role of IPRs in SSCI in New Zealand, or even other part of the world. On the other hand, the software industry has its special characteristics and backgrounds and cannot reflect the general SCI situation. In addition, the analysis is mainly based on qualitative data. In fact, the relationship between IPRs and SSCI is complex so large scale surveys are needed to quantify the research results. Second, IPRs indirectly influence SCI mediated by inter-organizational level relationships (Wang et al., 2016), therefore, the interaction between IPRs and inter-organizational relationships in SCI has to be investigated. Meanwhile, resource orchestration theory studies the breadth (across the scope of the firm), depth (across levels of the firm), and life cycle (at various stages of firm maturity) (Sirmon et al., 2011), thus, it is necessary to explore the interaction between the two level relationships across the scope and levels of the supply chain during both formative stage and operational stage of SCI. Future studies may apply resource orchestration theory to quantitatively examine the model in more general companies in a variety of industries.

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