A Qualitative Study of Knowledge Exchange in an Indonesian Machine-Making Company

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ARTICLE INFO	ABSTRACT

In a supply chain, company's ability to leverage knowledge that resides within the network of contracted and interacting firms is able to improve not only company performance but also the supply chain effectiveness as a whole. However, existing supply chain studies mostly discuss knowledge at company level, and rarely at internal-hierarchical levels. As a result, many things remain concealed, for example, how knowledge exchange between people across levels in a supply chain is influenced by the supply chain government. Moreover, most exsisting studies focus on a rigid hierarchical supply-chain mechanism, and hardly elaborate how interactions in a less-rigid mechanism. This article attempts to address these gaps, discussing how a supplier company that deals with innovation generation activities acquires knowledge that resides in its supply chain network. A qualitative case study about an Indonesian machine-making company has been chosen to represent one of supplier types in the automotive industry that deals with less-rigid mechanism. A social capital perspective is applied to shed light on how interactions between actors in a supply chain network influence knowledge exchange. The study finds out a positive relationship between social capital and knowledge exchange across levels and functions to help generate innovations, allowing the company to manage conflicting effect beliefs more effectively. The study also identifies a tendency of the company to regard intensive knowledge exchange as part of organizational learning process.

SARI PATI

Di dalam suatu rantai suplai, kemampuan suatu perusahaan untuk memanfaatkan pengetahuan yang ada di dalam jejaring di mana perusahaan tersebut berada tidak saja dapat meningkatkan kinerja perusahaan namun juga efektifitas rantai suplai secara keseluruhan. Namun studi yang ada tentang rantai suplai kebanyakan membahas pengetahuan yang ada antar perusahaan, dan jarang pada interaksi di dalam perusahaan hingga tingkat bawah. Hal ini menyebabkan adanya keterbatasan pemahaman kita terhadap beberapa hal,

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misalnya, bagaimana mekanisme rantai suplai mempengaruhi proses pertukaran pengetahuan antar individu di tingkat yang berlainan di rantai suplai tersebut. Selain itu, kebanyakan dari studi yang ada hanya berfokus pada mekanisme rantai suplai yang kaku atau berdasarkan hirarki (birokrasi) yang kaku, dan sangat jarang membahas interaksi pada mekanisme yang lebih fleksibel. Tulisan ini mencoba untuk mengurangi kesenjangan literatur tersebut, yaitu khususnya dengan membahas bagaimana sebuah perusahaan suplier menghasilkan inovasi dengan memanfaatkan pengetahuan yang ada di dalam jejaring rantai suplainya. Studi yang dilakukan adalah berupa studi kasus kualitatif tentang perusahaan inovatif pembuat mesin di Indonesia yang berada di dalam rantai suplai industri otomotif yang sangat hirarkikal dan prosedural. Untuk mengulas mengenai kasus tersebut, studi ini menggunakan sebuah pendekatan modal sosial, khususnya untuk mempelajari bagaimana interaksi sosial antara pelaku di rantai suplai mempengaruhi proses pertukaran pengetahuan. Temuan utama yang didapatkan dari studi ini adalah relasi positif atau saling memperkuat antara modal sosial dan pertukaran pengetahuan antar individu pada tingkat dan fungsi yang berbeda dalam menghasilkan inovasi. Di dalam relasi positif tersebut perusahaan cenderung memiliki kemampuan lebih baik untuk meredam dampak negatif dari perbedaan pandangan yang ada. Studi ini juga mengidentifikasi adanya kecenderungan perusahaan untuk mengandalkan pertukaran pengetahuan yang intensif sebagai salah satu cara efektif dalam proses pembelajaran organisasi.

INTRODUCTION

In a supply chain, company's ability to leverage knowledge that resides within the network of contracted and interacting firms is able to improve not only company performance but also the supply chain effectiveness as a whole (e.g. Lambert *et al.*, 1998, Barratt, 2004, Squire *et al.*, 2009). However, existing supply chain studies mostly discuss knowledge at company level, and rarely at internal-hierarchical levels. As a result, many things remain concealed, for example, how knowledge exchange between people across levels in a supply chain is influenced by the supply chain government. Moreover, most exsisting studies focus on a rigid hierarchical supply-chain mechanism, and hardly elaborate how interactions in a less-strict mechanism. This article attempts to address these gaps, particularly about how a supplier company that deals with innovation generation activities acquires knowledge that resides in a supply chain network. A qualitative case study about an Indonesian machine-making supplier has been chosen to represent one of supplier types in the automotive industry that deals with less-rigid mechanism.

To examine this issue, this study applies a social capital perspective to investigate how companies engaged in supply chain interactions manage their relationship-specific assets and knowledge exchange processes. Social capital has been viewed as a means of creating value for companies collaborating in a supplier-buyer relationship (e.g. Cousins *et al.*, 2006, Krause *et al.*, 2007, Villena *et*

al., 2011). However, such work has hitherto been hardly discussed how this relational construct may operate quite differently at various levels of analysis (individual, group, organizational) within the supply chain. Existing literature does not elaborate how social capital development at one level may (or may not) relate to interaction at other levels.

This paper aims to address the gaps through exploring the effects of social capital on knowledge exchange in one Indonesian machine-making supplier. The study suggests a positive relationship between social capital and knowledge exchange across levels and functions to help generate innovations, which allows the company to manage conflicting effect beliefs more effectively.

The next part discusses theoretical background on knowledge exchange and social capital in a supply chain context. After discussing the concepts, the paper presents the research methodology, followed by presenting the case study and the analysis. The paper concludes by drawing out the main implications of the study, before outlining opportunities for further research.

Theoretical Background

Knowledge exchange between buyers and suppliers is considered not only desirable but crucial for a company to sustain in business, especially where some degree of innovation through collaborations is required. However, knowledge exchange between suppliers and buyers is, however, extremely difficult to achieve as it requires close relationships between the parties. Zhou *et al.* (2014), for example, point out that in general companies may be reluctant to share knowledge with their counterparts because they think that they need to protect the company's knowledge or competitive advantage. Such a concern may be more critical in companies dealing with works that need different perspectives or knowledge from other parties to generate innovations, such as in joint project to develop new

products or apply new sophisticated technologies. This situation becomes more interesting in the context of supply chain where activities between suppliers and buyers are determined by the forms of governance (i.e. formal and relational), which might either enable or inhibit knowledge sharing.

Forms of Governance

In supplier-buyer relationships, the application of formal governance by buyers to suppliers might help reduce the perceived risks of investment (e.g. Mentzer *et al.*, 2001). The governance might also help overcome the problem of reluctant in knowledge sharing that can hamper flows of knowledge between companies (e.g. Szulanski, 1996). However, some studies also identify that formal governance can also discourage social interactions that are necessary to enable effective knowledge exchange based on shared understandings (e.g. Ghoshal and Moran, 1996). At the same time, relational governance offers an alternative way of promoting knowledge exchange, that too has its disadvantages, such as the potential loss of intellectual property rights.

Formal governance is usually applied at the beginning of cooperation between supplier and buyer. The purpose is to provide a direction for inter-organisational exchanges (e.g. Williamson, 1985, Poppo and Zenger, 2002) by referring to a set of rigid statements to guide the behaviours of related parties by specifying each party's roles and obligations to the pursuance of specific goals (Cannon *et al*, 2000 in Carey and Lawson 2011; Tsoukas and Vladimirou 2001). This type of governance is embodied in, among others, formal contracts, procedures, and rules.

At the same time, Macneil (1985) points out that supplier-buyer relationships not ony depend upon a formal governance but most importantly upon trust and reciprocity norms. Gulati and Singh (1998) support this by arguing that the existence of inter-organisational trust encourages interdependency and task coordination between

companies, helping them to work closely together with less controls. This suggests a different kind of governance in social networks, namely relational governance. In the study of the automotive industry for example, some assemblers favour developing a long-term commitment with their suppliers, not simply through contractual but also through relational governance (Smitka, 1991). Relational governance is defined by its use of flexibility, information-sharing, and the norms of solidarity present in a relationship (Carey and Lawson, 2011, Macneil, 1985). In this way, both parties engage in a set of informal norms that will affect their behaviour to preserve reputation and establish a long-term relationship (Carey and Lawson, 2011), a self-enforcing safeguard (Smitka, 1991) as an alternative control mechanism.

Considering that manufacturing supply chain mostly engages in a mechanism of strict formal governance (involving minimal flexibility when dealing with continuous and provisional features of practice), the question arises of 1) how companies or individuals manage the tension between intentionality and the barriers caused by each particular style of governance to acquire knowledge through joint practice, and 2) how governance influences the dynamics of social practice. Some studies have discussed the recursive relationship between practice and shared identity as part of knowledge generation (e.g. Orlikowski, 2002). In this respect, Leana and Buren (1999) point out that shared identity can shape the public goods facet of social capital. This indicates the influence of social capital on knowledge exchange.

A Social Capital Perspective

Social capital is used to help understand how interactions across levels interrelate to facilitate or constrain knowledge exchange. This research applies a social capital perspective provided by Nahapiet and Ghoshal (1998). This framework, which groups the facets of social capital into structural, relational and cognitive dimensions,

can capture its salient features at different levels. By examining the interrelationship of the three dimensions, the development of social capital either within or between levels to influence the occurrence of knowledge exchange can be identified.

The development of social capital concept through the work of organisational experts results in agreement that social capital represents the ability of actors to gain benefits by virtue of membership in social networks (Inkpen and Tsang, 2005). The direct benefits of social capital at organisational level are in the form of privileged access to knowledge and information. With particular reference to the supply chain network, some studies (Podolny and Page, 1998, Krause *et al.*, 2007) suggest that the network helps companies to acquire new knowledge through exchange processes.

Structural dimension is understood as the overall pattern of relationships between network members (Burt, 1992) and covers the issues of network ties, network configuration, appropriable organisation (Nahapiet and Ghoshal, 1998), and network stability (Inkpen and Tsang, 2005). Adler and Kwon (2002) suggest that network ties have significant potential to promote social capital transactions, and that their establishment is influenced by interpersonal relationships through informal interaction. In a supply chain network, strong ties between supplier and buyer provide better channels for the exchange process of complex issues or knowledge (Hansen, 1999).

Relational dimension focuses on personal relationships which develop through a history of interaction between individuals (Inkpen and Tsang, 2005). Several main issues come into play here, including trust and trustworthiness, norms and sanctions, obligations and expectations, and identity and identification (Nahapiet and Ghoshal, 1998), all focusing on the result of personal interaction (Granovetter, 1992). According to

Nahapiet and Ghoshal (1998), people satisfy their social motives (e.g. sociability, approval, and prestige) through personal interaction. In terms of knowledge exchange, the willingness of individuals to share knowledge is influenced by the level of trust between two parties (Nahapiet and Ghoshal, 1998; Inkpen and Tsang, 2005).

This research applies cognitive dimension in order to identify resources which provide shared representations, interpretations, and systems of meaning in groups (Cicourel, 1973), including shared language and narratives (Nahapiet and Ghoshal, 1998). Inkpen and Tsang (2005) suggest that cognitive dimension has two key facets: shared goals and shared culture. Shared goals refers to the extent to which the members of network share a common understanding and approach to the accomplishment of tasks and outcomes; shared culture refers to the extent to which norms of behaviour drive the relationship. This dimension also refers to the concept of a shared vision from Tsai and Ghoshal (1998) as collective goals and aspirations which inform how people should interact.

Existing literature on social capital mostly focuses on structural aspects and the general patterns of relationships between actors (Burt, 1997), emphasizing inter-connectedness and relational norms that are developed through intense social interaction (Granovetter, 1992). In their article, Nahapiet and Ghoshal (1998) coin the importance of a cognitive dimension that supply a more comprehensive approach to help examine the multidimensional constructs of social capital, particularly in terms of facilitating communication by groups or an organisation's members (Tsai and Ghoshal, 1998, Zheng, 2008).

Research Question
The study of social capital and knowledge exchange in supply chains, however, rarely acknowledges that social capital is likely to operate in quite different and perhaps contradictory ways within the participating organizations depending upon the precise inter-personal relationships to which it applies (Aggarwal *et al.*, 2011, Li *et al.*, 2014, Whipple *et al.*, 2015). The existing studies do not break down their analysis into relational benefits at different levels of analysis within the inter-organizational relationship.

Moreover, the existing literature of supply chain hardly elaborates how knowledge exchange through social interactions and dynamics occurs in the context of organizations that deal with activities to generate innovations. The studies mostly discuss the phenomena of knowledge sharing in a stictly control mechanism of supply chain. In the automotive industry, for example, most literature focuses more on component-making suppliers, and hardly on firms producing equipments or machinaries to support the production activities of other supply chain players. In such a particular context of innovative organization engaged in a supply chain, there is rarely any consideration of how the multi-faceted nature of social capital can have further consequences for knowledge exchange. This suggests a need to understand the complexity of interrelationships between social capital dimensions and how that might influence knowledge exchange.

This paper aims to discuss the gaps by addressing one research question: '*How does the relationship between social capital and knowledge exchange develop in a multiple-level of supply chain analysis (either in positive or negative way)?*'. This article discusses how social capital between actors across levels and boundaries plays its role along with intensified knowledge exchange as part of generating innovations. The main intention of this is to illustrate the conditions under which knowledge flow across organizational boundaries in the supply chain is generally enabled or inhibited.

METHODS
The methodological approach needs to be one

which can help the researcher gain an in-depth understanding of social interaction, and which relates to the occurrence of knowledge exchange influenced by a supply chain context. In this regard, case study research has been chosen as the main research methodology. In particular, the case study method is used in order to capture interactions were likely to affect the relationship between social capital and knowledge exchange processes (Bryman, 2008). Case study is defined by Creswell (2007) as: 'a qualitative approach in which the investigator explores a bounded system (a *case*) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving *multiple sources of information*, and reports a case *description* and case-based themes' (p.73, italics as original).

One company, namely ABC[1], has been chosen to represent the Indonesian machine-making industry. The case provides an exemplar of supply chain interaction that aims to generate innovative products (i.e. customised machines) to support the suppy chain. This particular context is believed will help us understand how innovations were generated in a strict-governed mechanism of supply chain. While component-making suppliers manufacture components according to buyer's standard design and strives to achieve cost reduction targets, machine-making companies on the other hand develop newly-designed products and technology and focus more on product innovation (cf. Dicken, 2003). So the main challenge of machine maker is to acquire engineering competency to be able to manage their business interests as well as complex engineering work. This study focuses on investigating knowledge exchange phenomena in the company's production activities.

Exploring supply chain interactions in the Indonesian context allows the study to be sensitive to, and capture, any distinct local cultural

influences on patterns of knowledge exchange. The automotive sector was chosen because automotive supply chains are not only of historic economic importance to many economies, they are also often well established and also characterized by high levels of interdependence amongst buyers and suppliers (Smitka, 1991).

In this study, the data collection took place in 2013, with the primary data source was qualitative semi-structured interviews (in the Indonesian language), supported by observation, focus groups, official documents and informal conversations. Interviews ranged across three levels within the company: company level (comprised the company's head of division and the representatives of buyer and supplier), management level (managers and section heads), and shopfloor level (project leaders and technicians). Interviews focused upon processes of knowledge exchange and perceived enablers and barriers related to organizational and social aspects. They ranged in length between 45 and 120 minutes and were recorded and transcribed. Repeat visits and interviews were also used when necessary. In total, 27 participants were interviewed (most of them were interviewed more than once), consisted of 12 participants from managerial level (division head and managers or department heads), 11 participants from non-managerial level (project leaders and technicians), and 4 participants represented suppliers and buyers.

In terms of reliability and validity assessment, this study addressed the concern about reliability specifically through the recording and transcribing of detailed field notes (interview transcriptions and memos) (cf. Silverman 2005 in Creswell 2007). Regarding the concern with validation, this study adopts two strategies to ensure the accuracy of research findings. The first strategy applies triangulation of sources, methods, and theories to the production and analysis of the empirical

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[1] All company names in this paper is treated anonymously for a confidentiality reason

materials (Stake 1995). The aim of this approach is to draw on the particular, different strengths of different data collection methods (Pettigrew 1997). It can thus provide the researcher with a foundation for revising their interpretation (Stake 1995). The second approach is to build trust with participants, to become acquainted with their culture, and to check for misinformation. This was done by sending the initial transcripts to the key participants (i.e. the management level), confirming issues which arose in the interviews and focus groups, and discussing any interpretations with them.

About the Company

Company Profile

ABC is an engineering company owned by one large Indonesian automotive group, which manufactures precision machinery, automation devices, and equipments such as precision cutting tools. Its activities incorporated not only job orders from customers, but also research and development (R&D) projects. One of R&D success stories was its development of a robotic system, which later gave ABC its competitive advantage. ABC's main buyers were mostly automotive component makers based in Indonesia, as well as automotive assemblers. ABC's main competitors were overseas machine makers. Most of these players manufactured just one product type (or non-customised machines).

ABC was led by an operation division head. The division consisted of six departments, each led by one department head or manager. The production department comprised four sections: machinery assembly 1 and 2, electrical, and robotic; each was supervised by a section head. There were about three to four groups in one section, and every group consisted of two technicians: a senior technician (acting as project leader: the person-in-charge or PIC) and a junior (or second-layer) technician. A number of helpers (usually contract-based workers) assisted the technicians.

The Scope of Work

ABC dealt with various customer needs, which were categorised (from the least complex): 1) copying from an existing machine, 2) copying a machine and making some improvements, 3) developing a new-designed machine according to the customer's conceptual drawing, and 4) developing a new-designed machine from scratch. Such a scope of work, from simple to complex job orders, indicates the ability of ABC to engage in complex production activities.

A project would start up after the customer approved the design concept. The engineering team developed the design details and a complete set of drawings would be distributed to production and purchasing departments. In the production department, the project was assigned to one group responsible for the order, from reading the drawing until installing the final machine in customer site. At peak times, one group would handle five to seven projects in parallel, each with a different schedule.

The basic process of manufacturing a machine consisted of several stages: part preparation (managing the raw materials procurement), middle assembly (preparing the machine frame and assembling some parts), final assembly (building the electrical circuits, assembling all the parts and completing the electrical wiring of the machine, its calibration and trial, and the final adjustments and finishing process), final inspection, and commissioning at the customer site. In reality, this process was not always linear; for example, electrical work might be carried out during middle assembly or at the final stage of production.

The tendency towards a non-linear process could also occur by virtue of changes to the design (usually in response to an additional customer request). In other words, the work process involved uncertainty, and flexibility was frequently

needed. This implies a challenge for the company to upgrade its people's engineering competency which was believed could be achieved through trial-and-error practices. In this respect, the company's engineering vision seemed to synchronise with the engineering passion of its technicians.

Business Challenge

Alongside company growth, ABC faced a new challenge, one which appeared to have resulted in tension between the pursuance of engineering competency and the company response to growing market demand. Conflict resulted within the organisation, relating in particular to time pressure resulting from an increased workload. Some technicians revealed that this made it difficult for them to discuss projects with colleagues. They tended to be concerned with satisfying the customer's needs, one stating that 'the customer is king' and another that they had to fulfil all customers' needs. In this way, technicians not only had to cope with any technical challenges but also were required to maintain a good relationship with customers.

Research Findings: The Relationship between Social Capital and Knowledge Exchange

ABC engaged in extensive knowledge exchange either within the company or between companies (customers and suppliers), particularly when handling customer orders. This section discusses how knowledge flowed across levels (company, management, and shopfloor) and its relationship to social capital.

Company Level

ABC regularly engaged in a number of extensive joint projects with network players. Joint projects with customers and vendors, for instance, involved a long-term schedule and seemed to include ongoing reciprocal interaction. The division head seemed to be satisfied with this intense interaction, regarding it as useful in building a common understanding of the customer's needs.

The engineering deputy manager leading the ABC team explained that ABC and the customer usually shared experiences of other companies:

> ... Our experiences with the customer can turn into a positive solution. When this customer in its daily activities [only] deals with similar technology, we 'inject' *(i.e. share knowledge from other companies)*, 'This, I have reference from this company, like this...' [At the same time] they *(i.e. the customer)* often [do] *genba*, benchmarking, to other places... So many inputs [from the customer for us] too...

Intensive knowledge exchange also occurred in the supplier-buyer relationship. ABC's position as part of one Indonesian automotive group seemed to be a key factor in gaining easier access to knowledge. The division head remarked:

> Because we are in one group, we already know what the need of the company *(i.e. the customer)* is for the following year... We heard [for example] that there will be something *(i.e. a company's plan)* next year, [so] we asked for the order [from the company] earlier...

ABC's ability to obtain prompt information about the customer's needs meant that it could negotiate and start preparation for a project ahead of time. As indicated earlier, this ability to gain extra time was advantageous for ABC. The indication is that this close relationship allowed negotiation to happen more easily. In other words, activating social capital with customers was critical to ABC's ability to cope with business pressures.

Knowledge exchange with the customer might continue during the manufacturing process, either at the customer site or on ABC's shopfloor. During the manufacturing process, a learning experience occurred for ABC's engineers through social interaction with customers. However, knowledge exchange with customers did not always occur according to ABC's expectations. One project

leader, for example, revealed that at times the direct connection between the customer and ABC management promoted miscommunication:

> ...the customer usually has several PICs *(i.e. person-in-charge).* One PIC [considered] that this [issue] was okay *(i.e. they both agreed),* [and] we prepared it for the following week. [But it turned out that] the second PIC contacted Mr. M *(i.e. the marketing manager)* directly: "This one hasn't been done". It turned into a misunderstanding. The top level wondered why [we] didn't fix it, and this became a problem. This becomes an obstacle.

A disconnect in communication might be caused by the fact that there was not just one point of contact between the customer and ABC. The implication is that miscommunication caused by multiple points of contact was inevitable and led to delays in machine delivery. This could negatively impact the customer's production process, which accorded with the customer's previous remark about the need for fast machine supply to support its business. The division head revealed that the possible cause of incomplete information in machine manufacture could be that the customer's representative did not know what to share (or that they forgot to share it) or that it happened on purpose.

Communication with suppliers was usually arranged by the purchasing department. During a project, suppliers often communicated directly with the production team, as remarked upon by one supplier:

> We usually have a meeting... [to discuss] the technical aspects... If for example there is a process that according to ABC is new, we are usually informed first..."This process, if you can make it like this... to avoid NG *(i.e. 'not good' or defect product)*, it starts from this and then this..." From engineering... [and also] PIC *(i.e. project leader)*... because the one who knows better about the assembling

process is the PIC... he knows where the critical point is.

This statement of '*being informed first*' indicates open communication between ABC and the supplier, reasoned by the purchasing manager as an attempt to reduce misunderstanding in handling a project.

The long-term relationship between ABC and its suppliers had created a shared understanding and a sense of trust, providing a foundation for the supplier to work without a formal contract. This tendency to omit paperwork resembled the approach taken by some ABC's customers. Here, ABC appeared to have attempted to align its activities with the pace of its customers, and also with the use of more relational (rather than formal) governance. There was an indication of cooperative behaviour from some suppliers. This can be identified from a remark from one project leader:

> I rarely encounter a problematic vendor... The problem is actually time... Usually the time allocated to them is quite tight... Vendors, the closer they are to us, the more effective our communication.

Most suppliers cooperated with ABC by developing effective communication. In this regard, the purchasing manager inferred that by supplying parts to ABC some suppliers might benefit from being connected to ABC's customers, in that a customer needing to replace parts of a machine produced by ABC would normally contact the supplier which made them, presenting the latter with an opportunity to build further cooperation with the customer. This potential to expand their network suggests another reason for the cooperative manner of some suppliers.

Management Level
Management level comprises the division head, department head (or manager), deputy manager and section head. As at company level, communication across departments at

management level seemed flexible and less hierarchical. For example, during the fieldwork, some managers were observed to talk freely with each other, when they met on the shopfloor or during lunch break.

The indication is that a culture of togetherness and reciprocal interaction had evolved between people across departments, underpinned by a common need for teamwork to accomplish work tasks. One technician echoed:

> In my opinion, here we are family. The familiarity here is really strong. If we don't know [about something], it's explained until we understand... The environment since we have been taken on is comfortable… They *(i.e. colleagues and managers)* welcomed us, answered [every question] kindly... With other departments it's just the same… the management welcomes us, there's no gap...

Regarding the relationship within the organization, the division head remarked that he had attempted to build a supportive culture. His expectation of solidarity among employees was aimed at building a culture of mutual respect, which seemingly corresponded with the company's preference of not blaming others for any mistakes. One project leader explained how the division head spelled it out:

> I remember that he *(i.e. the division head)* stated that everything related to this *(i.e. work)*. The management will never be angry if we make a mistake, for example [one that causes] the company loss because of mis-estimation, or [something else]; we will not be rebuked... He usually mentioned this in the big P5M *(Note: the weekly meeting attended by all employees)*.

In line with the attempt to build a learning climate, management also encouraged knowledge exchange, as remarked by the division head, for example, by conducting a weekly engineering sharing forum. Besides initiating formal activities such as engineering sharing, management also encouraged the learning process through direct practice. One technician gave this account:

> So there's a culture here... For example, a repeat order, it's not the same person who handles it... It's handed over to another PIC... This is perhaps one way to encourage communication. So if there's the same machine and a different PIC with no experience [of the machine], he can ask the experienced PIC.

This suggests a common understanding among ABC people, where they were encouraged to share knowledge. The production manager also remarked that a number of experienced technicians were usually invited to share knowledge when a project was underway. These illustrations indicate that within ABC a learning process was encouraged through social interaction.

Along with his attempt to build a company culture, the division head also developed non-technical systems to support work activities. He applied, for example, a strict approach to ensure a system was properly implemented. By monitoring system implementation he appeared to attempt to synchronise a passion for engineering with growing customer demand. This suggests that he played his part to orchestrate the company's activities by combining soft (applying a supportive culture) and hard (mechanistic) approaches. However, such a hard approach seemed to lead to tension between management and technicians, as revealed by some project leaders in the focus group. One remark is underlined:

> If [we talk about] technical [issues], I think there's no serious problem, but [with] non-technical issues [then there's a problem]... For example, company policy... – usually in the big-P5M, nobody dares speak up... I think it makes sense, because if we reveal [something] [we are] definitely 'seen' *(i.e. noted)*.

Technicians thus appeared to view company policy as something which hampered technical work, as opposed to the management perception that it could support technicians' work activity.

Shopfloor Level
This level comprised the positions of project leader and technician. Activities on the shopfloor were mainly concerned with building machines, and this involved coordination across departments (such as engineering, production, and purchasing) and intensive knowledge exchange either within or across departments, as explained by this technician:

> For me, [knowledge exchange doesn't occur] merely at the planning [stage] or the [production] process itself... During assembly, I often communicate with engineering. So for example a drawing dimension [looks] okay, but when it comes to assembly, it doesn't fulfil [the requirement]... So we consult with engineering, for example, "If I reduce the [dimension] range or expand [it], then what will the impact be on the [design] concept?" There is reciprocity [between] engineering and machinery production.

It appears that knowledge exchange occurred simultaneously and intensively among technicians. Some technicians remarked that knowledge exchange was also critical for the production team to build a common understanding about a machine design. The freedom to communicate appeared to promote learning-by-doing, which occurred from the first time a technician at ABC had to deal directly with a real project.

Such a self-learning mechanism appears to have encouraged technicians to communicate either with their leaders or peers when they faced a technical problem. One technician recalled how he communicated with others when he needed help:

> My feeling at the beginning was… "Can I do it?" I was ordered directly, like this and this… and I could only ask others how to do it. I learned bit by bit from others, and luckily the others embraced me, helped… Here, the people are open – as long as we ask for help in an urgent situation, they'll help.

Helping a fellow technician like this seemed to happen naturally among technicians, usually by first asking about the problem, and then discussing the machine's basic concept and any critical points needing to be understood before getting involved. The habit among technicians of helping each other did not always happen by virtue of personal initiative, but sometimes also as a result of being asked by their leader. Normally, this happened when one group encountered an urgent situation – perhaps an overdue deadline – when finalising a machine. One project leader explained that when his work was running smoothly, he walked around the shopfloor to find out how the other groups were progressing and to offer help if needed:

> Sometimes we're not only working for ourself, [but] also for our friends, helping another section... We knew their machines, the machines' trial deadline… [and if we see that] progress is still slow, we ask them whether we can help... [Then] we give help… We often walk around...

When one project leader recognised that another group had a problem he ordered his technician to help, delegating the task as he continued to monitor his ongoing work. The norm of solidarity was thus applied, embodied in a culture which valued the conduct of individuals to be conversant with other projects.

The technician seemed to believe that offering help to others would one day lead to this being reciprocated, an indication of how shared caused/effect belief evolved when one addressed a technical problem. It also seems that by being simultaneously connected to other technicians (either through a self-learning mechanism or being asked to help another group), a cognitive connection regarding technical issues could

be developed, and over time bonding might be strengthened.

Workers obtained shared knowledge of each other's problems from daily meetings, and the habit of helping peers handle their machine demonstrated the existence of shared knowledge about projects being undertaken on the shopfloor, a common understanding which some technicians implied increased their awareness of the company's situation.

This apparent association of a willingness to help their colleagues with concern for the company implies a perception on their part of having an identity bound up in being part of ABC. Technicians seemed to work together to conquer challenges to handle machines. There seems to be a correlation with the earlier discussion that technicians were not only interested in handling machines but also in maintaining a good relationship with customers, specifically as ABC representatives. One technician remarked:

> Even though I've never built that machine, I have ideas... [and we] exchange ideas... So although I have some projects [to handle], when I saw their machine was like that... *(i.e. having trouble)*... I gave [them] suggestions... "Try this and this"... helped them by [sharing] ideas...

These technicians seemed to obtain pleasure in handling new technical challenges, even when they had their own project to attend to. This implies that excitement in overcoming technical challenges might help technicians to engage in simultaneous interaction with others. This also implies interaction across boundaries alongside their passion of pursuing new knowledge.

Referring to the flexible attitude to work, there was an indication that the company trusted its technicians to make some decisions which needed rapid action, not least when at the customer site. One technician explained that technicians were permitted to make decisions on site unless approval was needed for additional costs. This flexibility not only gave technicians scope to improvise in their work but also to help each other, particularly noticeable when shouldering pressures resulting from a growing workload. This situation caused technicians in particular felt the pressure of potential delays to delivery because of their work being located at the last stage of the manufacturing process. To cope, they were in the habit of helping each other out, particularly at the customer site where a fast response was needed.

Derived from this discussion, it seems that by having shared knowledge of each other's machines and flexibility in making decisions, they could help address problems with their peer's machine. In this case, technicians trusted their peers to tackle problems related to their machine at the customer site ('entrusted problems'). The implication is that technicians could rely upon each other's help when under pressure to build new machines.

Along with the growth of the business, the company perceived that a more systemized way of work was needed, such as creating job description and performance appraisal system. This change seems to cause a different perspective among the shopfloor members, namely that having a job description might inhibit flexibility in handling work. One remarked that there were pros and cons to having a job description, particularly when it was related with performance appraisal. It appears that the passion for engineering (which tended to value flexibility) conflicted with a more utilitarian perspective demanding fairness (embodied in the appraisal system) (cf. Contu and Willmott, 2006).

The appraisal system was applied three years after ABC was established, as the company attempted to apply a more mechanistic approach due to the increased number of both employees and projects. One project leader discussed this issue further:

The measurement method states we have to be like this and this, but there is no job description. So it could be that if we fail to achieve a target, this becomes the reason for them to assess us lower.

From the discussion, it appears that technicians were disappointed that their appraisal was based upon subjective measurements and angry that their voluntary actions to help each other could not be measured. One participant even said the appraisal system should not be applied, because the culture of helping each other was already embedded in daily interaction.

In sum, the use of flexibility in handling engineering work implied the existence of some grey areas, one in particular which related to non-technical issues (this relates to the discussion of job descriptions). This was apparently able to trigger conflicting perspectives between technicians and management, particularly when attempting to determine a boundary between engineering passion and business interests. This suggests that lack of a cognitive connection could result in a potential drawback to the efforts of building engineering competency.

RESULTS AND DISCUSSIONS

The need for integrated activities when handling the complexities of engineering work seemed to have encouraged people in ABC to activate social capital which facilitated intense knowledge exchange. Positive facets of the company culture appeared to exist, which were aligned with a passion for engineering. A concern was raised, however, about the relevance of this to a business challenge which required a fast response to increased customer demand. In this situation, it appears that strong connections among organisational members across functions and levels had enabled them to cope with such challenges. The finding of the present study is summarised in the Table 1 below.

The table summarises the research finding: the relationship between social capital and knowledge exchange. The grouping is based on the strength

Table 1. The Relationship between Social Capital and Knowledge

	Enables knowledge exchange	Inhibits knowledge exchange
Strong social capital	**SITUATION ONE** **Company**: cooperative customers and vendors **Management**: routine visit to shopfloor, 'skills distributions' **Shopfloor**: self-learning mechanism, 'entrusted problem'	**SITUATION THREE** **Company**: not found **Management**: not found **Shopfloor**: not found
Weak social capital	**SITUATION TWO** **Company**: formal mechanism in joint projects with some institutions **Management**: formal relationship with some external parties **Shopfloor**: formal relationships with some external parties	**SITUATION FOUR** **Company**: competition among subsidiaries of the holding company **Management**: not found **Shopfloor**: the tendency of disappointment to the company

of social capital influence to knowledge exchange. Social capital strength is examined according to length of relationship, interaction intensity, interdependence and closure between individuals (Nahapiet and Ghoshal, 1998), and in the context of the fact that stronger or weaker social capital can either enable or inhibit knowledge exchange (Nahapiet and Ghoshal, 1998; Inkpen and Tsang, 2005). The researcher also compared field notes across the case study to enhance interpretation of the degree of influence of social capital. This approach helped increase the researcher's confidence in applying the table, particularly in terms of the variables used to depict the relationship between social capital and knowledge exchange. The table provides four possible situations that occured during interactions between individuals involved in projects or production activities in order to accomplish tasks: 1) stronger social capital enables knowledge exchange, 2) weaker social capital enables knowledge exchange, 3) stronger social capital inhibits knowledge exchange, and 4) weaker social capital inhibits knowledge exchange.

Situation one suggests that strong social capital emerged at every level of analysis. At company level, this situation is exemplified by ABC's attempts to synchronise activities in developing a project with customers and negotiating incoming materials with suppliers. Shared cognition seemed here to be developed through knowledge exchange as part of a learning process. Knowledge creation also occurred when technicians tried to conquer the complexity of a new design machine through simultaneous interaction, either among themselves or with customers.

At management level, this was identified in the habit of some managers to spontaneously exchange knowledge not only among themselves but also with technicians in order to handle technical problems. Moreover, at times a mechanistic approach was used and was apparently able to encourage learning and reinforce bonding (by institutionalising a supportive culture and assigning certain projects to technicians).

At shopfloor level, strong bonding seemed to have emerged during almost all activities, exampled by the entrusting to colleagues of problems encountered at the customer site. Organic solidarity appeared to stem either from a passion for engineering (to find enjoyment when trying to conquer machine complexity) or supportive systems (such as a self-learning mechanism).

The situation suggests that strong relational and cognitive connections seemed to create a positive environment in which knowledge exchange occurred. A positive working climate had apparently evolved as individual passion aligned with the company vision.

In contrast, situation four identifies weak bonding which could inhibit knowledge exchange. At company level, this situation might have hampered the supply chain mechanism, for example, when some members of the group tended to perceive other subsidiaries as their competitors, making them unwilling to share important knowledge when dealing with a project. This might incur problems, such as the increased cost of a delayed project schedule. This implies a dark side of social capital arising from being in the same group.

At the same time, it appeared that a potential weak connection between the senior manager and technicians not only became an obstacle to knowledge exchange (seen in the tendency towards silence), but also threatened their sense of solidarity. This was clear from the perception that some technicians had of being treated unfairly when dealing with non-technical issues (e.g. the application of job description and appraisal system). Lack of shared cognition might therefore have promoted distrust and hampered the integrated activities which had been developed.

In situation two, it seems that knowledge exchange still occurred despite bonding being hardly identified. The suggestion is that within some projects, knowledge exchange took place mainly based upon formal mechanisms rather than reciprocal interactions.

The findings above suggest how social capital between actors across levels and boundaries developed effectively along with intensified knowledge exchange as part of pursuing engineering competency when handling machine complexities. This situation implies that interaction at one level had a positive impact on other levels of the company. So for example, stronger bonding between technicians which emerged when handling machine projects improved the company reputation as a customised machine maker along with the growing number of successful projects.

In the context of the supply chain, the study indicates that at company level, the higher interdependency between a machine maker and its customer, the higher the possibility for involving relational governance (cf. Macneil, 1985), the higher the possibility of cognitive and relational dimensions interrelating to intensify knowledge exchange to generate innovation, and the greater the potential for structural connections to develop. These findings indicate that power relations were able to have multiple effects (positive and negative) on knowledge exchange through the activation of social capital in a situation where relational governance was applied in order to complement formal governance.

At management level, the findings suggest that the application of subtle power in a machine maker had the ability to promote the development of social capital at management level, in which knowledge exchange across levels was facilitated and innovations were generated (cf. Elg and Johansson, 1997). This study evidenced that this situation could develop social capital at organizational context, which enabled the

company to create flexibilities among the organisational members in handling different types of customers in a relatively short time.

At shopfloor level, the machine-maker that concerned more upon preserving the passion of pursuing engineering competency had encouraged the company to apply very subtle power (supplementing overt power) (see Lukes, 2005), activating both cognitive and relational social capital.

In sum, the findings show how both cognitive and relational connections may have developed either through a natural or a mechanistic approach, underpinned by strong shared identity and engineering passion among the organisational members. Such positive relationships between social capital and knowledge exchange across levels had significantly helped the company to generate innovations. The evidence also indicates that in this way the negative effect of a mechanistic approach of the supply chain could be reduced, allowing the company to manage conflicting cause/effect beliefs more effectively and to regard the situation as part of a learning process.

MANAGERIAL IMPLICATIONS

For managerial implications, this study found that group bonding among workers can have both negative and positive impacts on a company. It also found that a lack of group bonding can have a detrimental effect, for example when some technicians showed a tendency to work individually when the time of work increased, responding with passivity to issues at work and during a time of company crisis. From this, it is suggested that a company should pay more attention to both the existence and absence of group bonding, for example by promoting a climate which supports healthy group bonding, or by actively managing the group bonding which already exists to reduce any possible negative effects. As the company will face costs in the creation of this creative climate, this approach needs to be calculated strategically according to clear company goals.

CONCLUSION

In the machine-making cases (presenting a less-strictly governed supply chain), knowledge exchange mostly dealt with narrative knowledge achieved through social practice across boundaries (Orlikowski, 2002), in which innovative ideas were generated to meet the needs of buyers. Knowledge exchange occurred as a consequence of complex and dynamic sets of factors. The activation of social capital relied mainly on the interrelationship between cognitive and relational dimensions. This finding contributes to the framework of Nahapiet and Ghoshal (1998). The finding indicates that strong bonding between an organisation's members which developed through this interrelationship during work activities could spontaneously expand boundaries as part of efforts to generate new knowledge. This finding also contributes to the concept of how deliberate process (through the application of formal mechanism) could promote ongoing practice to generate improvement (e.g. Tsoukas and Vladimirou, 2001, Orlikowski, 2002).

This study suggests that relational governance and informal interaction were required to facilitate more complex (and tacit) knowledge exchange in a supply chain. Having said this, future research to differentiate product and process innovation as specific outcomes of knowledge exchange is still needed. It can help to focus on how a particular mechanism facilitates knowledge exchange to generate a specific type of innovation. A further extension of this present work would be to investigate other inter-organisational settings, such as the supply chain in a high-technology or service industry. The comparison of different intra- and inter-organisational settings may produce some interesting findings, for example the presence of different forms of governance or formal mechanisms which influence informal interaction as part of knowledge creation. ∎

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