

Managing Knowledge by the Information System and Game-Theoretic Approach

Summary

Knowledge is a source of competitive advantage. In small enterprises there is simultaneous cooperation and competition. Knowledge management research is focused on large firms. Collaboration among small enterprises and with large firms is common. Information systems and information technology play a paramount role in coordinating and controlling joint ventures. Information system is a key tool in the management of knowledge sharing. This paper offer game-theoretic approach to answer the questions under cooperation and competition: what to share, with whom, when, under what conditions is paramount, and the role of information system in managing knowledge in small enterprises.

Key words

Knowledge management, information system, Game-Theoretic Approach

1. Introduction

Firms have to manage 'knowledge sharing' under co-opetition. Skills in managing interorganisational knowledge flows have been shown to be a source of competitive advantage and managing cooperative relationships involves managing knowledge flows. In learning from them and IS is an enabler of new organizational designs. Hence, IS is a key tool in the management of knowledge sharing.

This paper analyses the role of IS/IT in the context of co-opetition using a game-theoretic model to identify the effects of knowledge sharing under co-opetition. The opportunities for knowledge sharing are assessed by an analysis of IS use in small and medium-sized enterprises (SMEs). This analysis demonstrates the opportunities for co-opetition. The paper first presents the background to SMEs and uses of knowledge. A description of co-opetition is given and the game-theoretic model is presented. The use of IS by SMEs is discussed. The paper posits a relationship between knowledge sharing and SMEs' attitude to the use of IS.

A key inhibitor or enable of information systems use in SMEs is competitiveness. SMEs are driven primarily by customer needs and their competitive environment profoundly affects the owners' perception of risk and business failure¹. Market uncertainty is usually strong as SMEs tend to have small market shares, few major customers, and are unable to influence price. For SMEs, customer numbers and customer power tend to be inversely proportional: small numbers of customers with considerable power dominate SMEs.

2. Knowledge management in SMEs

Knowledge management research is focused on large firms, yet SMEs are likely to be knowledge generators. SMEs present a curious position with regard to knowledge management. SMEs face the emergence of world markets and the need for quality, fast delivery and partnerships, just as their larger counterparts. Collaboration among SMEs and with large firms is common. The ability to share resources is important to SMEs that are unable to participate globally alone. Alliances encourage innovation, expand product portfolios, and forge new supplier relationships (Maynard, 1996). However, scarce entrepreneurial resources restrict SMEs' activities (Dyer, 1996).

Many SMEs wish to share knowledge, as they see cooperation with customers as a route to survival. For example, SMEs are frequently involved in product design for larger customers. Design involves innovation and understanding customer needs, yet this knowledge is seldom integrated into a wider strategic perspective, due to SME preoccupation with day-to-day viability. SMEs are in co-opetition with other SMEs and with larger firms. Knowledge-intensive SMEs are often employed as constituents of larger project teams. Even no knowledge intensive SMEs may compete on knowledge - often-explicit knowledge of a local market or product. SMEs can gain from knowledge sharing (by collaborative design, cost reductions strategies, and guaranteed orders) but they also have lots to lose.

Co-opetition

Co-opetition involves the recognition that firms may benefit from working together. Complemen-

¹ Storey, D., Cressy, R., Small Business Risk, 1995.

tors, those firms whose products add value to a second firm's products, are likely to share knowledge informally. Competitors may come together to leverage advantage through a temporary partnership by agreeing to share knowledge, in co-opetition is the notion that there is duality in every relationship - the simultaneous elements of cooperation and competition². Under co-opetition, *what to share, with whom, when, and under what conditions* is paramount. For SMEs this is unexplored but a game theoretic approach may offer insights.

Game-theoretic approach

Loebbecke & Van Fenema³ extend Van Hippel's analysis of the exchange of knowledge by introducing three additional dimensions:

1. *Synergy* - the extent to which cooperation yields additional value beyond the sum of the parties' individual knowledge. Synergistic value only exists if both players exchange knowledge.
2. *Leverage* - the potential of the 'knowledge receiver' to increase its value by exploiting the shared knowledge individually beyond the cooperation.
3. Use of 'received' knowledge may have a '*negative reverse-impact*' (NRI) on the 'sending' party. NRI is the extent to which a receiver's use of the knowledge lowers the sender's original value. The exchanged knowledge may be used by competitors and thus weakens its value to the original owner.

Loebbecke and Van Fenema explore the effects of synergy and leverage on knowledge sharing under co-opetition and also the effect of NRI on knowledge transfer (Figure 1).

Under conditions of weak leverage and weak synergy, from the sender's perspective there is little to gain or lose from knowledge sharing. Where there is weak synergy but a strong risk the receiving side may leverage the knowledge, propensity to share knowledge is low. Strong synergy and weak leverage describe a situation in which a firm would be eager to share knowledge in a 'co-opetitive' environment, since there is more to gain from synergy than the other party might derive from leverage. However, with strong synergy and strong leverage, the expected synergy may be offset by the expectation that the other party may gain additional value. From a sender's perspective, strong NRI lowers the interest in sharing knowledge.

If *both* parties can translate the knowledge into

adjacent business capabilities, they can exploit opportunities beyond the cooperation. This suggests partially diverging interests, typical of co-opetition, and the derivation of competitive advantage requires careful management of knowledge sharing.

		Leveragability by Receiving Party	
		Weak	Strong
Synergy of Co-operation	Weak	Ambiguous Attitude toward knowledge sharing Effect of NRI: Negative attitude towards knowledge sharing	Negative Attitude toward knowledge sharing Effect of NRI: Reinforced Negative attitude towards knowledge sharing
	Strong	Positive Attitude towards Knowledge Sharing Effect of NRI: Ambiguous Attitude towards knowledge sharing	Ambiguous Attitude toward knowledge sharing Effect of NRI: Negative attitude towards knowledge sharing

Figure 1. Synergy, leverage, NRI and knowledge

While these theoretical positions are intuitively appealing, there is little work that investigates empirically how co-opetition operates. This paper concentrates on the use of received knowledge by SMEs. In particular, the focus is on the use that SMEs make of this knowledge to develop their business. Thus, the role of synergy and leverage for the SME is explored, the role of NRI is left to one side for now. The paper does not consider the impact of the sender of the knowledge exchange. Further research is required to identify the role of NRI on customers. The paper first sets out the theoretical impact of synergy and leverage on SMEs using a model of SME IS use. This establishes a *priori* expectations that are tested using case data.

3. Managing knowledge in SMEs: the role of IS

SMEs use knowledge to manage day-to-day operations. It may be explicit and held on IS, or tacit and held by management. IS adopted by SMEs tend to be simple. Most SMEs view IS as a cost, and are reluctant to invest after start-up. However, some SMEs recognise the potential of IS to change their business - primarily those seeking growth. The customer is important in decisions on investing in IS. Customer influence is paramount at start-up when SMEs need to attract and keep customers and so are extremely flexible, and when the SME is established as a preferred supplier to a major customer. Otherwise, customer power is weaker.

Levy develop an analytical framework, the 'focus-dominance' model, to investigate the potential for SMEs to get value from IS capabilities (Fig-

² Brandenburger, A., Nalebuff, B., *Co-opetition*, 1996.

³ Loebbecke C., Van Fenema P., *Towards a Theory of Interorganizational Knowledge Sharing during Co-opetition*, 1998.

ure 2). The framework has two dimensions: strategic focus for IS/IT adoption and customer dominance. The first reflects the two main purposes of IS/IT adoption: cost reduction or adding value. Cost reduction represents the traditional use of IS/IT based on their incremental and reactive adoption. The value-adding strategy focuses on the adoption of IS/IT for competitiveness - a possible source of success differentiation for SMEs. The second dimension, customer dominance, is a key issue for SMEs. SMEs are dependent upon their customers in two instances. First when they are starting up, and second if the SME is a first tier supplier to a major customer, it will have few customers. Yet, as SMEs grow market share, their customer base increases and individual customers have less power.

The two dimensions create four competitive scenarios for SMEs termed efficiency, coordination, collaboration and repositioning (Figure 2). The key characteristics of each quadrant are defined below.

The focus of IS use in the *efficiency* quadrant is on control, primarily financial control. There is no integration with business strategy. The IS are concerned with improving the efficiency of internal processes and are, consequently, viewed as a cost to the business. Knowledge is used to manage day-to-day operations.

In addition to the systems used for cost control in the efficiency quadrant, in the *coordination* quadrant the main use of IS is to improve customer care due to the larger customer base. Databases manage customers across departments. Interdepartmental communication is the role for IS. The objective of the IS is to improve the effectiveness of business processes but the focus remains internal. There is limited integration of IS with business strategy. Again, the primary use of knowledge is to manage internal operations.

The third grouping is the *collaboration* quadrant. Here, there is an increase in the sophistication of the technology used. SMEs need to communicate and exchange information with customers in a cost-efficient manner by using systems such as e-mail and EDI.



Figure 2. Four competitive scenarios for SMEs

The use of IS is integrated with business strategy, particularly when dealing with major customers. Often, customers are the driving force behind the introduction of new IS. Knowledge transfer and sharing is seen in this quadrant, while much of it is related to operations, exchange of performance management information provides some value to the firm.

The final quadrant is *repositioning* - the integration of IS with business strategy. Here IS are an integral and tightly woven part of the business strategy of the SME. Therefore, it influences the direction of business strategy as well as react to it. The role of information changes to how the firm may grow and learn rather than maintaining current direction. The need is for systems to support a performance-focused management style. Knowledge is critical in enabling the owner to manage business growth. Thus SMEs can be considered to be *repositioning* themselves for future growth.

Figure 3. maps the types of information used in the quadrants. This provides a background to identify when SMEs may find knowledge sharing and co-opetition pertinent.

Co-opetition is unlikely to be an issue for those SMEs with a cost-focus strategy. Their systems are primarily internally focused. Levy show that the primary growth path for SMEs is from *efficiency* to *coordination*. Information is used to manage the business. In the *efficiency* quadrant the tendency is to provide sufficient information to satisfy basic record keeping only. *Coordination* is an extension of this, with increasing firm size making it necessary to develop databases to provide information access. In neither quadrant is information shared with customers to develop the relationship further. It follows from Figure 3. that the main use of information in the efficiency and coordination quadrants is to support internal day-to-day operations. Therefore, the expectation is that both synergy and leverage will be weak, leading to an ambiguous attitude to knowledge sharing.

In contrast, the value-added focus suggests co-opetition may benefit SMEs that are either required to share information with their customers (*collaboration* quadrant) or that use IS as a means of changing and developing the business.

Customer Dominance	Weak	Coordination Formal, operational, shared, Internal use only through the use of internal databases	Repositioning Internet provides access to external information that owners use to develop business strategy. Introduction of knowledge management systems is to improve effectiveness and competitiveness
	Strong	Accounting systems provide basic formal information. Owner's implicit knowledge of the business is vital for survival. Efficiency	MRP, EDI provide means of exchange of operational information with customers. Performance measurement systems provide information shared with customers Collaboration
		Cost Focus	Value Added Strategic Focus

Figure 3. Information use in SMEs

Information exchange may become core to business strategy (*repositioning* quadrant). SMEs in the collaboration quadrant have a few key customers that expect information on product and process quality. This exchange is critical to the relationship, hence synergy tends to be strong. Few SMEs use information to exploit knowledge on their own and hence leverage is likely to be weak.

The expectation for co-opetition forces in the collaboration quadrant is that synergy is likely to be strong as the cooperation may lead to additional value from information to both parties. For example, SMEs that engage in cooperative design are likely to gain synergy as they learn from customer requirements, and reuse the knowledge in other projects, increasing interdependency between SMEs and their customers.

Large customers encourage SMEs to focus on a narrow product range, to hone their skills and reduce costs progressively. SMEs are encouraged to enter open-book arrangements where both parties have full access to product data, but this usually ends up as a form of control, not exchange. However, the SME is less likely to be able to increase the value of the knowledge outside the relationship, hence leverage is likely to be weak. SMEs possess weak leverage due to their poor ability to manage both the knowledge exchange process and the outcome, while larger firms are more able to lever the knowledge gained.

The co-opetition framework (Figure 1.) suggests that overall there will be a positive attitude towards knowledge sharing.

The repositioning quadrant contains dynamic SMEs that recognise the value of information and

knowledge as a strategic resource to enable change. The businesses often concern information exchange, and there is an expectation of strong synergy. The SMEs use information to improve, grow and attract other customers, indicating leverage is likely to be strong.

A similar analysis of co-opetition in the repositioning quadrant suggests that synergy is also strong as both parties recognize information as a strategic resource.

However, as indicated in Figure 3. repositioning SMEs recognise the need to exploit shared knowledge to develop their business strategy. Hence, leverage is likely to be strong.

The issue of concern here is how any knowledge transfers and hence co-opetition forces are managed by SMEs.

4. Research method

Case studies are a useful approach exploratory research such as this as it is possible to pose reflective questions. Additionally, case study research is effective when theory is relatively underdeveloped. In particular, when the boundaries of the research are not clear, there is a need to investigate the issue within a real-life context, drawing on the views of a number of sources. Case study research provides a means to review theory and practice iteratively. Multiple cases ensure that common patterns are identified rather than generalized from what might be chance occurrences. Interviews are a key feature of successful cases.

Business strategy is discussed, competitive relationships are reviewed, the strategic use of information is identified, and the role of information systems is explored. IS models are used to demonstrate the role of IS in each SME, in particular the purpose for which IS/IT is used, and whether it is for production, management information or customer support is mapped. Competitive analysis is used to uncover whether, and in what form, information is shared between SMEs and their customers. Future strategies and information systems potential are discussed with interviewees.

This research involves operationalisation of the constructs co-opetition and knowledge sharing. Neither of these has well-developed definitions or dimensions. However, for the purposes of this exploratory research, the models used identify what the firms exchange and the systems they use to exchange them. It also identifies the competitive forces at work in the SMEs' sectors. Soft systems analysis reveals if the exchange take. The notion of co-opetition is taken here to refer to SMEs' interac-

tions with their major customers. For some SMEs they will compete with their own customers - 'classic co-competition' - while other SMEs face the prospect of their dominant customers grabbing value from the exchange for themselves. Further, large firms often encourage their suppliers through information exchanges and the dissemination of 'best practice'. If the knowledge SMEs exchange with their customers is explicit (as is focused on here), then this knowledge is less sticky and can leak to competitors. Thus even when competition is not dyadic, explicit, component or public, knowledge may escape to other SME competitors. Lastly, the paper focuses on explicit knowledge.

5. Discussion and conclusions

To date little is known about how co-opetition operates in the real world and still less of its impacts of SMEs. Researchers are still debating issues of the role of knowledge sharing in organisations. This exploratory research attempts to add to this debate by understanding the context of co-opetition in SMEs, the role of IS in managing knowledge, how the co-opetition forces of synergy and leverage manifest themselves and how SMEs attempt to manage the knowledge-sharing process. Managing inter-organizational knowledge processes play a prominent role in sustainable competitive advantage. The game-theoretic analysis provides a structure for modelling knowledge sharing under co-opetition.

First, the paper establishes that SMEs need to manage knowledge and that they are often players in a co-opetitive game. Then in order to analyze the role of knowledge sharing under co-opetition, the paper introduces a game-theoretic model. This model identifies three co-opetitive forces, two of which, synergy and leverage, are analyzed further. The paper also demonstrates that there are four dominant roles for IS use in SMEs and that these form the focus of SMEs' explicit knowledge management. The forms that knowledge management can take are discussed.

There is evidence of synergy and leverage in some cost-focused SMEs. The reasons for this are summarized below. The game-theoretic model engenders expectations of knowledge-sharing opportunities and co-opetition in value-added focused SMEs. This is largely found to be the case and again this is discussed further below. For all SMEs the ways in which they manage knowledge transfers are explored.

The theoretical proposition outlined is that SMEs with a cost-focused strategy are likely to have weak synergy and leverage, and hence an ambiguous attitude to knowledge sharing. However, the analysis demonstrates that synergy is strong. This appears to be because of the strong relationship between the SME and its customers in the production area. The exchange of information, particularly in product design, is critical to both businesses. However, leverage from the information is only evident in the coordination quadrant, where firms are looking for growth often through new markets for existing products.

For value-added SMEs, the analysis supports the proposition that those in the collaboration quadrant exhibit strong synergy and weak leverage, while repositioning SMEs exhibit both strong synergy and leverage.

Thus, co-opetition forces do impact on SMEs, though the context is significant. Some SMEs employ tactics, sometimes through the use of IS, to mitigate and exploit these forces through knowledge-sharing management, although their efforts are largely unsuccessful. However, in the majority of cases the SMEs fail to exploit knowledge explicitly in either managing the business or in providing customer support. Both of these areas need to be developed further if SMEs are to grow and develop.

SMEs need to consider how to make themselves receptive to exchanged knowledge, and flexible and responsive enough to gain competitive advantage if this is ephemeral. It may be that knowledge is bundled with other physical assets and that there are prerequisites for using the knowledge fully. SMEs are knowledge creators, but are poor at knowledge retention. Part of the resolution of this lies in the SMEs' own hands. They need to be proactive in knowledge-sharing agreements, to recognize knowledge has value and the value added derived from knowledge exchange. While some SMEs here expect new technology to open up global markets, their collaborations are essentially local. SMEs will be more vulnerable as interorganizational IS spread and the world gets more information exchange intensive. At minimum, SMEs need to recognize that these forces exist. Recognition is the first step in management, although often the SMEs cannot mitigate the forces, especially from major customers. They may, however, be able to gain more value internally from the knowledge they are forced to share. As with many issues in SMEs, the owner manager attitude is paramount. The fact that most of the knowledge shared by

SMEs is explicit suggests that some management of the sharing process is the hands of the SMEs.

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