A VALUE OPTIMISING STRUCTURE IN VIRTUAL ENTERPRISES FOR MANUFACTURING SYSTEMS

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Abstract: *The significant increase in inter-organisational collaboration during the last two decades has led to the development of the so called Virtual Enterprises, defined as an organisation which can optimally utilise operational internalisation and externalisation to improve its performance. Such Virtual Enterprises are different from traditional companies in that they can achieve tasks beyond their internal capacity, and focus more resources on core competencies thus becoming agile. To transform a traditional organisation into a virtual enterprise, it is necessary to create an alliance management function for managing alliance operations. This paper describes the development of an externalisation and internalisation (EI) management function as the core of a virtual enterprise, organised around an organisation's value stream function. This value stream oriented structure further ensures that the optimisation is value adding.*

Keywords: Virtual Enterprises, Manufacturing Systems, Optimisation, Alliance Management, Value Stream, Functional Structure, Core competencies, Externalisation

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1. Introduction

The escalation of inter-organisational collaboration during the last two decades (Cravens et al., 2000; Robinson, 2003; Mathews, 2006) has lead to the concept of Virtual Enterprise (VE). Virtual Enterprise is defined as an organisation which can optimally utilise operational externalisation to improve its performance. Different from traditional companies, VEs can achieve tasks beyond their internal capacity (Pollalisa and Dimitriou, 2008; Hoffmann, 2005), and focus more resources on core competencies thus becoming agile (Arnold, 2000).

This paper recognises the fact that as a special kind of social organisations, VEs should have a special functional structure different from that of traditional companies. This functional structure should be enable an organisation to optimise its external (i.e. alliance) and internal operations, and thus help it become a virtual enterprise.

2. Alliance Management Function

Research indicates that organisations with a dedicated alliance management function created more value from alliances than those without such a function (Heimeriks, 2010; Dyer et al., 2001; Kale et al., 2001). The following responsibilities of the alliance management function are identified in the literature:

(1) Coordinating alliances to improve their compatibility (Duysters et al., 1999; Kale et al., 2001)

(2) Internal resource allocation for alliances (Kale et al., 2001)

(3) Gaining stakeholders' support for alliances (Kale et al., 2001)

(4) Evaluating alliance performance (Draulans et al., 2003; Kale et al., 2001)

(5) Alliance knowledge management (Kale et al., 2001; Draulans et al., 2003; Bonner et al., 2004)

In Kale et al.'s field research (2001), they found that global leaders such as Hewlett-Packard, Parke-Davis, Eli Lilly and Oracle have created a totally separate "alliance management team" to perform such responsibilities, and the team is usually headed by a middle or senior level

executive with the title of "Vice President" or "Director Strategic Alliances". Companies that create such a team adopt a variety of approaches to organise or locate the team within their organisations (Kale et al., 2001).

- A large computer company, as described by Kale et al. (2001), has 4-5 key strategic partners with each of whom it has several alliances. It has set up separate alliance teams (each comprising an alliance manager supported by a technology and marketing manager) to coordinate its multiple alliances with each strategic partner. These alliance teams in turn report to a corporate-level alliance function.
- On the other hand, a large global financial services company, as described by Kale et al. (2001), has organised its alliance teams by geography. A separate alliance team coordinates and supports all alliance activities in its four geographical regions of North America, Europe, Latin America and Asia including Japan. A senior Vice President coordinates the effort of all these individual teams.
- Kale et al. (2001) also found that some multi-business sample companies organise their alliance teams on a divisional or sector basis. Each relevant division/sector has its own alliance team, if necessary, and teams from different divisions are occasionally coordinated further at the corporate level.

Thus, Kale et al.'s field research (2001) indicates that alliance management teams can be organised as central functions for either focal partners, geographies or divisions as the case may be.

Because tasks along a firm's value streams can be either externalised or internalised, the alliance management teams can be viewed as the central functions of the externalised part of the value streams, and this part can be called externalisation structure (or alliance structure). The alliance management teams and their surrounding functions form a firm's externalisation structure. For example, the externalisation structures of the above mentioned organisations (organising alliance management teams around focal partners, geographies or businesses) can be depicted in Figures 1, 2, and 3 respectively.

Although the alliance management teams act as the central functions of a firm's externalisation structure, they have difficulties in becoming the central functions of a firm's entire structure due to their relatively little role in managing the other part of the value streams – the internal part (also called as the internalisation structure).

However, if the alliance management teams' responsibilities can be extended to overcome such insufficiencies, they have the potential to become one of the central functions of a VME's entire structure, thus giving clear guidance as to how to construct a VME's functional structure.

This extension of the alliance management function is referred to as externalisation-internalisation (EI) management function in this paper.\

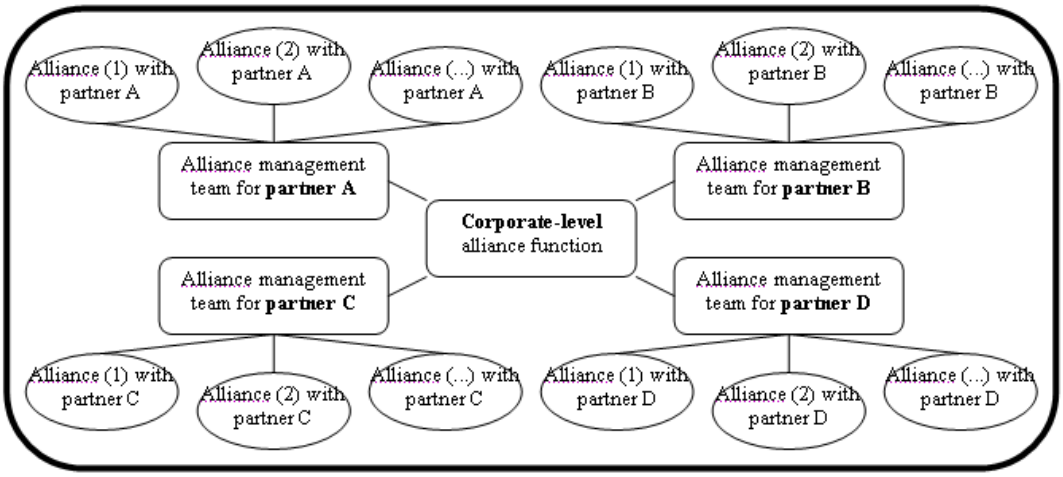

Figure 1 Externalisation structure around focal partners

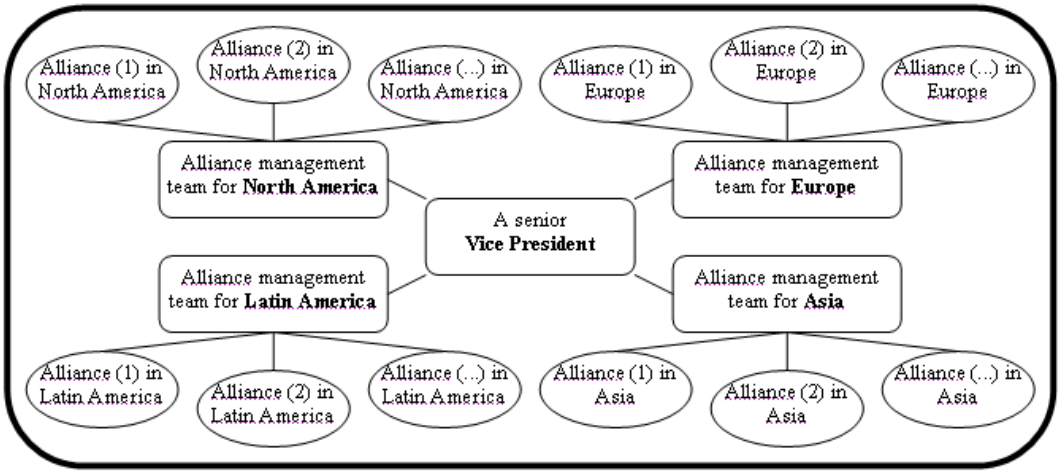

Figure 2 Externalisation structure around geographies

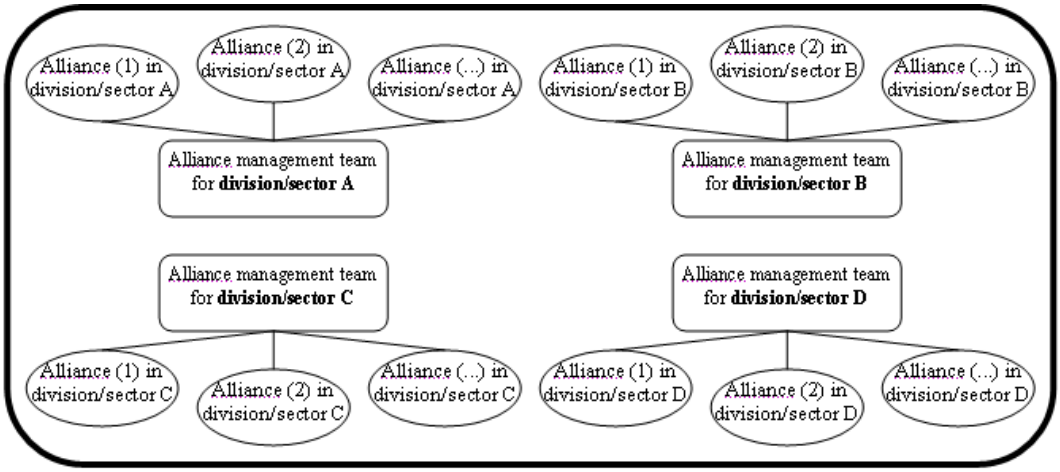

Figure 3 Externalisation structure on a divisional or sector basis

3. Responsibilities of EI Management Function

3.1 Responsibilities Enhancement

The responsibilities of the alliance management function form the basis on which the responsibilities of the EI management function are designed. Firstly the responsibilities identified in the literature are all upgraded to cover both externalisation and internalisation (see Table 1).

Table 1: Upgrading alliance management function to cover both externalisation & internalisation

Covering externalisation		Covering both externalisation & internalisation (EI)
(1) Coordinating alliances to improve their compatibility	→	**(1) Improving EI compatibility**
(2) Internal resource allocation for alliances	→	**(2) Internal resource allocation for EI**
(3) Gaining stakeholders' support for alliances	→	**(3) Gaining stakeholders' support for EI**
(4) Evaluating alliance performance	→	**(4) Evaluating EI performance**
(5) Alliance knowledge management	→	**(5) EI knowledge management**

The reasons for the upgrading are specified as follows.

(1) **Improving EI compatibility**

An organisation can have alliances that are often in direct conflict (Duysters et al., 1999; Kale et al., 2001). Incompatibility may also exist when internal operations are taken into consideration. In the JVCO joint venture between Hexagon and NAMCO (Ariño and Doz, 2000), the alliance operations resulted in the cannibalisation of NAMCO's products, since the alliance products used the same channels and distribution space as those for NAMCO's products.

Alliance operations might also be not compatible with a company's strategies, thereby requiring adjustment. This situation was found in the field case studies by the authors.

> When started, Shanghai Fu Qin Machine Company (SFQMC) delegated almost all of its manufacturing activities to suppliers, and itself focused on product development. After several years' successful operation, based on cost reduction and performance improvement, the company is now gradually investing in land and manufacturing equipment for building new factories. This reflects the shift in strategy from externalisation to internalisation. The company carefully checked the compatibility between its alliances, and operations to be internalised, and began to eliminate, step by step, its collaborations with some suppliers. Such elimination cannot be too quick, since the company still needs time to learn the relevant operations; in fact, new collaborations with suppliers were set up for the company to learn from its suppliers.

> The ultimate objective of the company's internalisation, e.g. heat treatment, is that "We are able to do the procedure by ourselves completely; external suppliers are only called upon when orders exceed our capacity". This also means that collaborations with relevant suppliers won't be removed completely.

Sometimes, even when no conspicuous incompatibility exists, a firm's EI situation may still need to be adjusted to improve overall business performance, as demonstrated by EADS acquisition of BAE SYSTEMS 25 percent stake in EADS Astrium in 2003.

> The acquisition is a key element in EADS' effort to restructure and integrate all its Space interests in the UK, France, Germany and Spain. EADS will gain the strategic and restructuring flexibility required by the current space market conditions.
>
> Source:
> http://www.paradigmsecure.com/
> http://www.defense-aerospace.com/

The Toyota case study (Ahmadjian and Lincoln, 2001) exhibited a similar situation. Toyota's building of an in-house capability in electronic components, thus scaling down its dependence on Denso, was due to the escalating importance of automotive-electronics technology and Toyota's increasing difficulties in evaluating Denso's pricing and delivery of electronic components caused by the information asymmetries between the two companies.

The research by Hoffmann (2005) also demonstrated the importance of aligning a company's alliance portfolio with the company's strategic goals. Thus, it can be concluded that not only the compatibility among a firm's alliance operations needs to be improved, but also their compatibility with the firm's internal operations and overall strategies.

Internal resource allocation for EI

Similar to external operations, internal operations may also trigger significant internal resource allocation. What's more, carrying out internal operations often requires much more internal resource allocation than if the work was done externally; this is one of the main reasons why alliances are often sought as alternatives. The Concorde project

involving collaboration between Sud-Aviation and British Aircraft Corporation (Dussauge and Garrette, 1999) was triggered since both firms realised that they did not possess the financial and human resources needed to launch alone an aircraft of this kind. Other similar case studies were also found in the literature, e.g. the Stork-Wärtsilä joint venture (Douma et al. 2000), and the IBM, Siemens and Toshiba's R&D venture (Brouthers et al. 1995),

(2) **Gaining stakeholders' support for EI**

A company can have a variety of stakeholders, such as shareholders, employees, local government, etc. Gillespie and Teegen (1995) indicated that "Stakeholders may be able to exercise influence over an alliance at its inception as well as during its life span. Formal and informal programs must be in place to ensure the support of all relevant stakeholders, such as customers, suppliers, other alliance partners, financiers and unions".

Similarly, stakeholders may also be able to exert (great) influence on internalisation decisions. For example, in the Renault-Volvo alliance (Bruner and Spekman, 1998), the Volvo's Executive Chairman underestimated the resistance from a number of key stakeholders, which directly resulted in the failure of his proposal to merge Renault and Volvo. As another example (Zhang and Li, 2001), the proposal by the Japanese partner of buying 60% of the international joint venture (IJV) equity shares held by the Chinese partners was strongly opposed by the local Chinese IJV general manager, since he believed that the proposal would damage the interests of the IJV and the employees. The proposal could not be passed without the general manager's approval in the board, and the manager also had called for all employees not to cooperate with the consultant team sent by the Japanese headquarters for restructuring.

It can be concluded that both external and internal operations need stakeholders' support. The situations could become even more complicated when external parties have been involved in alliances, in which relevant tasks need now to be internalised.

(3) **Evaluating EI performance**

Since the early 20th century, financial performance measures such as return on investment began to be used by companies such as Dupont and General Motors to control and improve

their financial performance. These performance measures became important management information for decision-making, and were not questioned by academics and practitioners until the 1980s (Johnson and Kaplan, 1987). One reason for the questioning is that such measures are difficult to use to measure the day-to-day operation of a company (Dixon, Nanni, and Vollmann, 1990; Kald and Nilsson, 2000).

During the 1990s, performance measurement models combining both financial performance measures and non-financial performance measures were presented. Kaplan and Norton (1992) presented the Balanced Scorecard model that can be used to evaluate business performance from four perspectives: (1) customer perspective, (2) internal perspective, (3) innovation and learning perspective, and (4) financial perspective. Maisel (1992) further demonstrated the causal links among these four perspectives, and Kaplan and Norton (1996) included these causal links into their Balanced Scorecard model. The balanced scorecard model has been adopted in companies like Sears (McLemore, 1999), Boeing (McLemore, 1999), General Electric, Michigan Consolidated Gas (McLemore, 1999), Petrobras, Australian Healthcare System, and Madison Paper Company (http://www.bscol.com/).

Neely (1998) suggested a "what-how" performance measurement model based on Kaplan and Norton's Balanced Scorecard, indicating that top-level performance measures should be mapped on the four perspectives of the Balanced Scorecard model, and low-level performance measures should have explainable causal links with these top-level performance measures. Neely (1998) called these causal links as assumptions and indicated that companies should challenge these assumptions to establish a perfect performance measurement system, and the challenge process is the learning process of the company.

Another important model is the Performance Pyramid System (PPS) originally developed by Judson (1990) and improved by Lynch and Cross (1991; 1995). PPS divides a company's performance measures into two sides (i.e. a company's internal and external sides) and four levels (i.e. a company's overall level performance measures; individual business unit level performance measures grouped under the market and financial headings; key measurement level of customer satisfaction, flexibility and productivity; the bottom

level measures such as product quality and delivery reliability). The contribution of PPS lies in its mapping of performance measures to a company's organisational structure, and mapping these measures on the day-to-day operations of business units.

The recent trend of increasing vertical disintegration and outsourcing in many industries has shifted the focus from a pure intra-organisational towards a more holistic inter-organisational view of the overall value system. The result has been an increasing awareness of the importance of inter-organisational management control (Source: http://www.ifm.eng.cam.ac.uk/csp/projects/johannes.html).

The above review of performance measurement evolution illustrates the importance of performance measurement for internal operations. These approaches' influence is so great that they became the outset of many of the subsequently designed alliance evaluation approaches. Thus, it is appropriate to say that performance measurement for internal operations has at least the same level of importance as that of performance measurement for external operations. This is why the responsibility of "evaluating alliance performance" is upgraded into "evaluating EI performance".

(4) **EI knowledge management**

Knowledge management practices are used by many organisations to capture, share, and create useful knowledge for improving their alliance operations (Pollalis and Dimitriou, 2008; Heimeriks, 2010; Kale et al., 2001; Draulans et al., 2003; Bonner et al., 2004; Tsang, 1999). Hoang and Rothaermel (2005) suggested that firms should assess whether they are providing sufficient resources and organisational support to leverage alliance experience, e.g. increasing efforts to codify knowledge and creating systems to coordinate and disseminate information between alliance managers across projects and across time. Firms must be able to account for the results of their alliances and deliberately engage in organisational routines to methodologically capture, process, and disseminate knowledge (Emden et al. 2005).

In addition, knowledge management practices are also deliberately used for learning & capturing alliance partners' knowledge (Jiang and Li, 2009; Chen et al., 2009; Goerzen,

2005; Revilla et al. 2005; Kandemir and Hult, 2005; Chen, 2004; Hermens, 2001; Inkpen, 1998, 2000; Parise and Henderson, 2001; Simonin, 1999; Tsang, 1999), and at the same time, protecting own knowledge competencies (Norman, 2001, 2002; Das & Teng, 1999; Baughn et al., 1997; Jordan, 2004).

However, knowledge management has very diverse roots (Drew, 1999), none of which supports that knowledge management is only for external operations:

- Academically, the field of organisational learning popularised by Senge (1990) dates back to the late 1970s.
- Innovation is another contributing thread. Firms' core competencies are essentially knowledge-based sources of competitive advantage.
- Other academic roots of knowledge management can be located in the business process re-engineering (BPR), IT management, and strategic control literature.
- Practically, the BPR trend of the early 1990s has led to widespread adoption of new systems, notably ERP systems. The growth of the Internet and Corporate Intranets serves as platforms for information and knowledge dissemination.
- Governments are concerned with promoting economic growth, for which knowledge is an important driver, especially in the high-tech and service sectors. Encouragement of innovation in knowledge-intensive firms, dissemination of best practices and investments in education have become hot political issues.
- Knowledge management can also generate new competencies for firms, which attracts relevant stakeholders (e.g. shareholders).

Companies like Siemens (Davenport & Probst, 2002), IBM (Mertins et al 2001), ABB (Hoegl and Schulze, 2005), Ricardo (Ward, 2005), Unilever (Drew, 1999), and Volkswagen (http://www.vw-personal.de/www/en/wissen/wissensmanagement.html) have successfully established their knowledge management systems, which mainly focus on improving the efficiency of their internal operations.

Knowledge management also plays an important role during mergers/acquisitions,.

For example, in the acquisition of MediaOne by AT&T (Armistead and Meakins, 2002), merger-specific knowledge was collected and stored in a repository, the objective being to help teams track their progress against each other and share lessons learned in real-time. In the merger of BP and Amoco (Armistead and Meakins, 2002), knowledge management also played an important role to make sure that lessons learned before were taken into consideration, a broad range of views from employees as to how the merger had gone could be collected, and merger-specific knowledge could be shared and captured throughout the merger process.

Thus, knowledge management is not restricted to an organisations external operations, but has a much wider scope of application. It is a crucial factor in the improvement of both external and internal operations. This is why it is upgraded to further cover an organisation's internal operations.

3.2 Additional Responsibilities

The above discussed responsibilities are **updates** of those of the alliance management function. This section discusses some new responsibilities included in the EI management function to further strengthen its central functioning role within a VME. These new responsibilities are listed in Table 2 as (6) and (7).

Table 2 New responsibilities included in the EI management function

Covering externalisation		Covering both externalisation & internalisation (EI)
(1) Coordinating alliances to improve their compatibility	→	(1) Improving EI compatibility
(2) Internal resource allocation for alliances	→	(2) Internal resource allocation for EI
(3) Gaining stakeholders' support for alliances	→	(3) Gaining stakeholders' support for EI
(4) Evaluating alliance performance	→	(4) Evaluating EI performance
(5) Alliance knowledge management	→	(5) EI knowledge management
	New	**(6) Ensuring value stream optimisation**
	New	**(7) Designing competency protection**

(5) **Ensuring value stream optimisation**

Value stream optimisation is the objective of configuring external and internal operations. If separated, EI configuration loses its significance in helping improve overall performance of the new enterprise. Thus, continuous value stream optimisation signals wise usage of alliances, and also provides guidance to EI configuration.

Adding the responsibility of "ensuring value stream optimisation" into the EI management function essentially guides proper EI configuration along value streams. Since "value stream" can be defined as "the set of all the specific actions required to bring a specific product" through the following three critical management tasks (Womack and Jones, 2003), this responsibility strengthens the EI management function's central position in a VE.

- The problem-solving task running from concept through detailed design and engineering to production launch;
- The information management task running from order-taking through detailed scheduling to delivery;
- The physical transformation task proceeding from raw materials to a finished product in the hands of the customer.

(6) Designing competency protection

Competency risks due to alliances have been well documented in the literature (Das & Teng, 1999; Duysters, 1996; de Man & Duysters, 2004; McCutcheon and Stuart, 2000; Brouthers et al, 1995; Norman, 2001; Norman, 2002; Quintas, Lefrere, & Jones, 1997; Dickson et al. 2005). The reasons why alliances might particularly trigger competency risks can also be justified. Since VMEs have a much higher possibility to become heavily dependent on alliances than traditional manufacturing companies, it is important to set up a defence system against competency leakage. This is why the responsibility of "designing competency protection" is included in the EI management function.

A variety of competency protection approaches can be followed to help the EI management function design a proper defence system. These approaches are summarised as follows:

Identifying competencies (Norman, 2001; Baughn et al., 1997)

Assessing risk of competency leakage prior to initiating alliances:

(i) estimating the consequences of competency leakage (Baughn et al., 1997); (ii) anticipating partners' intents of competency acquisition (Norman, 2002; Baughn et al., 1997); (iii) assessing partners' absorption capability (Norman, 2002; Baughn et al., 1997). "Firms should make it clear prior to alliance formation that they are aware of the possibility of unauthorized learning" (Das & Teng, 1999). Jordan (2004) indicated the importance of "recognising potential dangers".

Creating a moving target by continuously improving competencies (Nair and Stafford, 1998; Shultz and Saporito, 1995)

Controlled information disclosure: To prevent opportunistic learning, "a firm may withhold information from a partner. Management of knowledge flows and communication has been identified as a critical method for protecting knowledge (Baughn et al., 1997) ... Because the structure of information flows influences how much a partner can learn (Levinson & Asahi, 1995), limitations on the amount of information sharing and the frequency of communication can protect against the loss of competitively important knowledge (Kumar & Seth, 1998)" (Norman, 2002). Das & Teng (1999) also suggested limiting the exposure of tacit knowledge and know-how to their partner firms. Norman (2001) indicated that to protect knowledge, information flows could be limited to one person (gatekeeper), limited to a few people (communication stars), or completely excluded from alliances. "Participating firms should be aware of what the appropriate access points are, and what information is channelled through them. When consistency and coordination regarding information access is not established within a firm, multiple requests for information may be undertaken by a partner firm at different levels, departments or divisions. The firm may unwittingly provide information through one access point that would have been restricted by another." (Baughn et al., 1997)

Using patents (Norman, 2001)

Using high-tech labelling for direct protection to limit access, such as special inks and dyes, holograms, and electronic passwords and signatures (Nair and Stafford, 1998)

Establishing reward practices for competency protection (Norman, 2001; Baughn et al., 1997)

Staff training & education (Norman, 2001; Baughn et al., 1997; Das & Teng, 1999; Jordan, 2004): Norman (2001) indicated that both top management and alliance management should stress protection of core competencies; human resource management should take the responsibility of educating & training personnel about competencies protection; an information manager can be designated to an alliance, and act as a consultant in cases where employees feel that the circumstances surrounding knowledge protection are vague or unclear. Jordan (2004) indicated "the important role that the individual played in the control of knowledge flows. Attempts to protect the knowledge leaks were often directed at individuals, who were sometimes instructed to withhold certain types of information in formal meetings".

Choosing proper alliance structure among equity & non equity forms (Norman, 2002; Baughn et al., 1997; Das & Teng, 1999; Das & Teng, 1996; Mitchell et al., 2002)

Task design: (i) to limit partners' access to competencies (Norman, 2001; Baughn et al., 1997); (ii) to perform certain tasks to maintain relevant expertise (Dussauge & Garrette, 1999). Greater emphasis should be placed on task partitioning and modular working (Jordan, 2004). Langlois (2002) explains that by "breaking up a complex system into discrete pieces which can then communicate with one another only through standardised interfaces within a standardised architecture – one can eliminate what would otherwise be an unmanageable spaghetti tangle of systemic interconnections". "While the modular design approach still required extensive exchanges of information, these exchanges between partners could occur despite physical separation of personnel, in particular engineers, which allowed core technology to be 'walled off' and thereby protected" (Jordan, 2004).

Restriction on alliance location: Baughn et al. (1997) comment: "Conducting joint activities within one's own firm allows the partner access to one's facilities, providing a window to ongoing processes and access to knowledgeable personnel. This greatly increases the permeability of the interface, with a strong potential for outflow of knowledge to the partner … By placing the joint activities in a third location, the parents can more effectively decide what technology to include in the venture and what to exclude." Thus, to protect competencies, partners' access to facilities and non-alliance personnel can be limited (Norman, 2001; Das & Teng, 1999).

Alliance staffing design: e.g. Norman (2001) suggested the use of information managers in alliances to monitor and act as consultants for competency protection. Baughn et al. (1997) indicated that "The personnel comprising the alliance interface serve both as gatekeepers of information and as potential receptors of partner skills. The knowledge, skills, and abilities of the individuals selected for partnership roles represent a critical determinant of information access. Interface personnel should be well briefed in what skills can and cannot be shared, and should be aware of the strategic costs and benefits of collaboration (Hamel, 1990; Pucik, 1988)". To have one's own staff in key posts in an alliance is also a significant mechanism for effective managerial control (Das & Teng, 1999). Jordan (2004) indicated that "rapid turnover of staff in a number of the alliance projects did … produce a rather unexpected benefit, namely it reduced the risk that tacit knowledge would leak to partners".

Alliance timing design: "Many firms limited their involvement with alliance partners, initially transferring older technologies, and gradually introducing newer technologies over time. Temporal limitations may also be stipulated in the alliance contract, limiting the planned duration of the alliance, and thereby the window of learning opportunity for each partner" (Baughn et al., 1997).

Counterbalance activities (Norman, 2001; Lui & Ngo, 2004; Dussauge & Garrette, 1999): activities that could produce a force counterbalancing the effects of possible resource leakage: e.g. an agreement forbidding a partner to compete with the company within 10 years after the alliance dissolves.

Monitoring: Norman (2001) suggested the use of an information manager to: (i) scrutinise critical knowledge used in alliances, and ensure that it has been classified accurately and that alliance employees are properly informed and educated; (ii) continuously ensure that employees are actually following the guidelines and procedures established by the knowledge protection system. Norman (2001) also suggested the monitoring of contacts with partner employees. Baughn et al. (1997) indicated that "Monitoring information flow is likely to prove more difficult. However, information regarding information requests by the partner can be tracked, as well as compliance with expectations to control information flow (hiring practices, personnel rotation, technical contribution), and geographic or product expansion by the partner firms". Das & Teng (1999) suggested tight monitoring of alliance operations as a useful way of controlling relational risks.

4. EI Structure

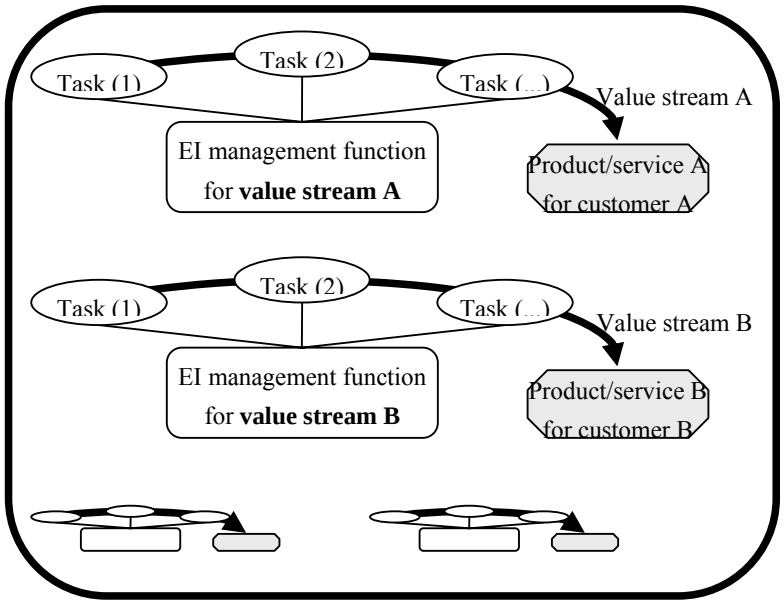

Figure 4 EI structure around a VME's value streams

As depicted in Figures 1, 2 & 3, organisations' externalisation structure can be organised around focal partners, geographies or divisions, with alliance management functions as central links. However, after the alliance management function is upgraded to EI management

function, especially for the responsibility of "Ensuring value stream optimisation", it becomes difficult to create an organisation's EI structure around focal partners, geographies or divisions, since the EI management functions now supervise a firm's value streams, which are organised around the organisation's customers/products/services!

Constructing EI structure around an organisation's value streams (see Figure 4) is perceived as more beneficial than the original externalisation structure around partners/geographies/divisions, because it complies with both the academic and practical trends which are in favour of customer-oriented operations. For example, one innovative costing method designed to deal with the deficiencies of traditional costing systems is Activity-Based Costing (ABC) (Roztocki et al., 2004). ABC, pioneered by Robin Cooper, Robert Kaplan, and H. Thomas Johnson (Cooper, 1988a; 1988b; 1990; Cooper and Kaplan, 1988; Johnson, 1990), is a costing methodology used to trace overhead costs directly to cost objects (i.e. products, processes, services, or customers). ABC can radically change how managers determine the mix of their product line, price their products, identify the location for sourcing components, and assess new technology (Turney, 1989). Another example is the lean approach. Originated in the auto industry in Japan, the lean approach has been adopted by many of those companies which could be characterised as "world-class" (Rafuse, 1996). Lamming (1994) argued persuasively that all significant product value systems will ultimately adopt the lean approach. The basic idea of lean operations is to identify entire value stream for each product, to eliminate any waste along value streams, to precisely synchronise the production rate with the sales rate through continuous flow in small-lot production, and to offer customers exactly what they want (Womack and Jones, 2003).

Based on the responsibilities discussed above, the boundaries between the EI management function and other functions along the value streams can be clearly perceived (see Table 3).

Table 3 Boundaries between the EI management function and the value streams (other functions)

EI management function		
(1) Ensuring value stream optimisation Improving EI compatibility	Guiding →	Other functions along value streams
(2) Internal resource allocation for EI	Fuelling →	

(3) Gaining stakeholders' support for EI	Smoothing →	
(4) Designing competency protection	Defending →	
(5) Evaluating EI performance	Evaluating →	
(6) EI knowledge management	Refining practices →	

5. Further Validation

To validate the model proposed in this paper, 7 manufacturing organisations (5 in China and 2 in the UK) were investigated. These companies were selected to form a theoretical niche in terms of industry, size, location and market scope, as shown in Table 4. Other selection criteria included:

(1) The case study companies must be manufacturing companies.

(2) The case study companies must have alliance experience, thus possessing the data/knowledge sought by this research.

The evidence found in these organisations, together with the evidence collected from the literature, including both researcher views and literature case studies, provide support for triangulation evidence.

It is important to view this research in terms of its limitations. Although the model has been validated through triangulation evidence, it would have been useful to study the companies through direct observation of the implementation of the proposed Value Optimising Structure. By directly observing how the companies customise and implement the structure according to their specific situations, it would have been possible to incorporate into the model the knowledge based on practical experience.

Table 4 Theoretical niche of selected case study companies

		A	B	C	D	E	F	G
Industry (Code)	Iron and steel forgings (3462)	✓						
	Steel foundries (3325)		✓					
	Motor vehicles and motor vehicle equipment (3710)			✓				
	Motor vehicle parts and accessories (3714)			✓				✓
	Construction machinery and equipment (3531)				✓			
	Metal heat treating (3398)					✓		
	General industrial machinery and equipment (3569)						✓	
Size	Small ≤100	✓ 50				✓ 65		
	100< Medium ≤250				✓ 148		✓ 200	
	250< Large		✓ 290	✓ 21,000				✓ 18,000
Location	China (developing country)	✓	✓	✓	✓	✓		
	UK (developed country)						✓	✓
Market Scope	National		✓ China	✓ China		✓ China		
	Regional	✓ China ; Japan			✓ South East Asia			
	Global						✓	✓

Further research could be carried out in more UK companies to confirm/challenge the case study results of this research. Companies in countries other than the UK and China could also be included to enlarge the boundary limits of the theoretical niche.

In its current form, the model is independent of the characteristics of manufacturing organisations. Additional research could be carried out to prioritise the elements within the model according to organisations' characteristics, such as industries, locations, size, etc., so that the model could help organisations focus their precious resources on those issues with higher priorities.

Specific to this area of research, small companies generally attracted much less research attention than large international companies, and therefore little guidance could be found in the literature regarding the issues specific to small companies, such as how to ensure continuous value stream optimisation, and how to establish knowledge management system. Due to the distinguishing features of small companies, e.g. less influence upon their value stream parties, non existence of large professional community for adopting standard knowledge management practices, specific guidance is needed for small organisations to resolve the relevant issues.

6. Conclusion

Building a dedicated VE functional structure is a critical step of transforming a traditional company into a virtual enterprise. The proposed structure provides guidance about how to formulate their functions in order to achieve an optimal combination of internal and alliance operations. Based on the functional structure, an organisation can also for example adjust its departmental structure to reinforce a proper implementation of the relevant functions.

The alliance management function researched in the literature provided a similar structure for managing a company's alliance operations. However, because a virtual enterprise closely combines its internal and alliance operations, this structure is not capable of managing the entire VE. Recognising this deficiency, the paper extended the alliance management function through upgrading its existing responsibilities and adding new ones, to enable it to manage both internal and alliance operations.

Instead of being organised around a company's divisions, the structure proposed in this paper is organised around a company's value streams. Doing so offers some advantages: first, it facilitates a company to be functionally value adding through focusing functions on value streams; secondly, because value streams are combinations of internal and alliance activities,

doing so helps improve their holistic performance, rather than the performance of individual activities.

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