INTEGRATION OF GLOBAL TRANSPORTATION AND TRANSNATIONAL VALUE CHAINS: A DYNAMIC CAPABILITIES PERSPECTIVE

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ABSTRACT

This paper seeks to integrate the global transportation network and MNC value chains. Currently, the two areas are investigated in relative isolation by two distinct groups of scholars. Value chain analysts internalize transport factors; and transport analysts internalize the demands of MNCs. Encompassing the two intellectual arenas within a single conceptual framework to highlight their inherent interdependence generates key issues requiring further investigation: (1) how does the design of global transportation network generate a dynamic capability that translates into value for MNCs; (2) how do MNCs derive strategic resource advantages from the integrative designs of global transportation network and disaggregated value chains; and (3) how can network location and routing decisions associated with integration paths lead to more effective integrative network designs. A conceptual framework for studying the design integration of these two networks is developed so that the competitive value of network integration can be better understood by MNCs. This framework provides a platform upon which future research can be based.

Keywords: value chain analysis, dynamic capabilities, resource-based view, network structure, transportation costs

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INTRODUCTION

Researchers have begun to recognize the role of global transportation in the competitive performance of disaggregated, geographically dispersed value chains (Liu & Kao, 2004; Morash & Clinton, 1994; Tracey, 2004) and the difficulty of managing them (Boyd, Hobbs, & Kerr, 2003; Cohen & Mallik, 1997; Mentzer et al., 2001; Pontrandolpha et al., 2002). Effective management of transportation services has lagged behind their strategic importance because few multinational firms have well-defined logistics strategies that integrate the design of the global transportation network into value chain management (Nootenboom, 1999). Therefore, developing value chains designs capable of adapting to the structural and economic changes in global business conditions around the world has been difficult to attain (Sheppard & Kent, 2002).
Managing a complex web of demand expectations and supply logistics requires greater integration of the transportation processes that comprise the substance of relationships not only among value chain partners but also between the global transportation infrastructure and the value chains of MNCs. At present, however, our understanding of the integration process is fragmented because extant research provides few points of intersection. Value chain analysts internalize transport factors; and transport analysts internalize the demands of MNCs. As long as these two networks are studied as separate entities, the influence of transportation factors such as global ports and trade channels on disaggregated, geographically dispersed value chain processes will be difficult to ascertain.

Extant research is advanced by providing a theoretical framework for studying the value of integrating these two networks. The value of design integration is argued to arise from the capacity of the global transportation network to be a strategic capability that enhances the competitive performance of the value chains of MNCs. By examining the points of intersection between the two networks and the strength of the connectivity between the two networks, the strategic significance of network design integration to the value creation process is established and a more comprehensive analysis of the competitive performance of global value chains can be conducted.

The scale and scope of disaggregated value chains and their geographic separation from respective global markets requires an integrative framework (Anderson & Hasson, 1998; Morash & Clinton, 1997; Tavasszy, Ruigrok, & Thissen, 2003) that extends beyond the transactional and functional nature of the relationships between MNCs and transportation service providers (Baier & Bergstrand, 1999; Bougheas et al., 1999; Carter & Ferrin, 1995; Evers & Johnson, 2000; Glaser & Kohlhase, 2004; Holcomb & Manrodt, 2000; Limao & Venables, 2001; Liu & Kao, 2004; Lu, 2003; Oum & Walters, 1996; Zarzoso et al., 2003) to the strategic nature of the path overlap of the networks. This study, in identifying the network overlap and integration requirements, provides a strategic framework for studying the integrative network designs.

LITERATURE REVIEW

Developing a comprehensive framework for integrative network designs involves an investigation of the value integration points (i.e. goods, information and knowledge) and two types of capabilities (i.e. transformation and transmission) illustrated in figure one. Transformation refers to activities of each MNCs that convert goods into something valued by markets whereas transmission refers to the connectivity infrastructure that links these transformation activities into a unified value chain design. Designing an integrative framework for the value chains of MNCs involves an analysis of the relationship between 1) the capacity to transform goods into something that is valued by the market and 2) the capacity to transmit goods from one transformation activity to another through the global transportation network.

Design integration can occur among value chain partners, within the global transportation network, and between the global transportation network and value chains of MNCs. Integration within the global transportation network involves developing and maintaining the relational connectivity between multimodal ports and the transportation service providers so as to establish the trade routes that are used by many industry value chain partners. Network integration among value chain partners involves relational attributes that create value for the network as a whole by the way the value chain activities are configured. Both analyses are valuable but incomplete. Determining the value created by the integrative design of the global transportation network and value chains of MNCs as two large interconnected systems requires an investigation of the activity overlap between the two networks.

Our understanding of this overlap is fragmented because the two areas of research have been investigated in relative isolation by two distinct groups of scholars. Table 1 summarizes the four streams of research for the two networks; 1) value chains from their a) strategic and b) operational dimensions and 2) the global transportation network as a combination of a) a multimodal port infrastructure and b) transportation services. These two streams of research, while addressing the competitive and operational nature of their respective networks, have not adequately addressed the design integration of the two
networks. There are, however, common areas of interest that can act as important categories to begin the study of integrative designs between the two networks.

Global value chains has been investigated from competitive and operations perspectives. Research on the competitive nature of value chains (Porter, 1985) has highlighted the role of location decisions (Beamon, 1996; Bloemhof-Ruweard, et al., 1995; Fisher 1997; Fuller, et al., 1993; Oliver & Webber 1992; Petersen, Ragatz, & Monczka, 2005), that when linked to objectives for the entire value chain and a contextual evaluation of design alternatives (Arntzen et al., 1995; Berry & Naim, 1996; Camm et al., 1997; Mourits & Evers, 1995; Revelle & Laporte, 1996; Towill, et al., 1992), can provide opportunities for improving their competitive performance (Cohen & Mallik, 1997; Copacino & Rosenfield, 1992; Houlihan, 1985; Roberts, 1990; Scott & Westbrook, 1991; Townhill, 1997).

Operations strategies and tactics for managing these value chains have emphasized effective inventory management and control (Alderson, 1957; Anupindi & Akella, 1993; Cachon & Fisher, 1997; Garg & Tang, 1997; Stank & Crum, 1997; Stenger, 1997; Tracey, 2004), production planning and scheduling (Graves, et al., 1998; Kruger, 1997; Lederer & Li, 1997; Levy, 1997; O’Brien & Head, 1995), and information sharing and coordination (Fisher & Raman, 1996; Gavirneni, et al., 1998; Lee, et al., 1997; Mason, et al., 2003; Moinzadeh & Aggarwal, 1997) as mechanisms for within network integration.

Similarly, there have been numerous studies on the global transportation sector. Research highlights the design (Bhatnagar & Viswanathan, 2000, Koh, 2001; Paik & Bagchi, 2000) of a dynamic transport value system (Robinson, 2002) that is linked to the development of national and regional economies (Button & Taylor, 2000; Gillen, 1996; Murray et al., 1998; Wilson et al., 1998). Studies have focused on port development (Hershman, 1999; Koh, 2001; Mak & Tai, 2001; Walter & Poist, 2004), and management (Notteboom & Winkelmans, 2001), routing and scheduling (Gayialis & Tatsiopoulos, 2004), as well as competition between ports (Flaming & Baird, 1999; Haralambides, 2002; Heaver, et al., 2000) and service providers (Francois & Wooton, 2000; Friebel & Niffka, 2005; Shaddon, 2000). Integration within the transportation network has focused on the relationship between port authorities and transportation service providers.

There is research overlap between within the value networks of MNCs (i.e. value chain analysis and supply chain management as strategic and operations tools) and within the global transportation network (i.e. cooperation between ports and service providers in design and operation). Little research emphasis, however, has been given to the cross network overlap. The point where the overlap has been studied is in the management of transportation costs (Baier & Bergstrand, 1999; Bougheas et al., 1999; Carter & Ferrin, 1995; Glaser & Kohlhase, 2004; Limao & Venables, 2001; Liu & Kao, 2004; Oum & Walters, 1996; Zarzoso et al., 2003) that emphasizes shipper-carrier partnering relationships (Evers & Johnson, 2000; Holcomb & Manrodt, 2000; Lu, 2003). While the focus on buyer and supplier attributes highlights the importance of cross network member to member relationships, it does not address another critical dimension of integration; that between the two networks as a whole. The former is a transactional relationship whereas the latter is a design relationship. Cross network design integration requires an investigation that extends beyond the transactional relationships between network members to the strategic relationship of the designs of the two networks. This moves the analysis in three directions; 1) from within to between network integration, 2) from transactional to design relationships, and 3) from operational to strategic factors.

**INTEGRATION FRAMEWORK**

Even though transportation management can be an essential tool for reducing costs and improving services of global value chains, it is often ignored as a critical source of a sustainable competitive advantage (Morash & Clinton, 1994; Liu & Kao, 2004; Tracey, 2004). The role of transportation in value chain performance, through its evolution from a cost center to a core competence capable of producing cost and differentiation advantages, highlights the strategic value of the global transportation network in the design of competitively superior global value chains. The analysis and management of the value creation process has not, however, kept up with the growing complexity of
disaggregated global value chains and the emergence of mass customization in markets scattered around the world. Managing the scale and scope globalization, thus, requires greater understanding of the strategic importance of integrating transportation activities that comprise the substance of relationships not only among value chain partners but also between the global transportation network and the value chains of MNCs.

Given that disaggregated, extended value chains could not exist without the complex trade infrastructure created and managed as a shared global transportation network, integration of these two networks can significantly affect firm performance through its influence on the quality, timing and cost of a boundary-less network of valuable transportation activities. This integration, however, can be difficult to manage because of the high degree of complexity inherent in each network. A recent study (Sheppard & Kent, 2002) found that 70% of the CEOs of MNCs were unable to manage their value chains even though 85% of them identified their design and management as the single, most important aspect of global performance improvements. This study also suggests that the reason for the disparity between their importance and management arises in firms that do not view their value chain designs and the corresponding transportation activities as core competencies capable of producing strategies supportive of the structural changes in value creation inherent in globalization.

Effective value chain management in such an environment involves the integration of both networks so that the capacity to disaggregate activities of global value chains is enhanced by the capacity of the global logistics network to provide the connectivity infrastructure that spans local, regional, and national boundaries. First, expanding the focus of value chain analysis to include the global transportation network enhances the ability to identify and respond to global opportunities and threats as they emerge. Second, the timing and cost of building the global transportation infrastructure can temporarily tax the ability of MNCs to effectively manage their supply chains. Since the value of dynamic capabilities is hidden, derived from the ability to create and support other strategic resources, the likelihood of strategic implications on value chain management to be disregarded even though the cost of their development is high. When ignored, the performance of value chains can be temporarily or permanently impaired, thereby limiting the life of any previously attained global competitive advantage. Since global value creation activities are embedded in the global transportation network, the ability of MNCs to manage their value chains warrants an investigation of the value created from design integration of network activities.

The value created from integrating these two networks arises, most obviously, from linking network members together with complementary information, knowledge and skill requirements together so that they can be transmitted across networks. This member to member relationship between transportation service providers and firms affiliated with a given value chain is the most obvious point of integration. This type of member to member integration, while important, presents an incomplete picture of the value of integrative network designs. The transactional nature of member relationships across networks doesn’t lend itself to recognizing the impact of the design decisions of the global transportation network in developing the value chains of MNCs into strategic resources capable of producing and sustaining a competitive advantage in a global environment. Cross network design integration in a global economy is a strategic imperative that also involves assessing the between network integration requirements that can facilitate the reconfiguration of value chains as global business conditions continue to evolve.

There are four components of integrative network designs; 1) network interdependence as the condition that determines the extent to which the networks depend on each other for essential resources and skills (Thompson, 1967), 2) integration paths as the network overlap that adds value for MNCs, 3) integration requirements as the activity and relational specifications that shape the strategic focus of network integration, and 4) integration value as the ability build dynamic capabilities and strategic resources from integrating the two networks.
Network Interdependence

There are three types of interdependence between the two networks; pooled, sequential, and reciprocal (Thompson, 1967). Pooled interdependence has the lowest coordination and integration requirements since the activities of network members are assumed to be independent. Sequential interdependence has higher requirements since individually performed activities are a series of value creation activities that affect one another, with the weakest link having a substantial impact on competitive performance. The highest network integration requirements arise under conditions of reciprocal interdependence since there is a high degree of activity specialization and a high degree of network overlap in performing these activities. Focusing on the contingent nature of the interdependence between the two networks can prevent the loss of strategic resource advantages arising from design-caused defects found to originate from the lack of integration and coordination (Josephson, 1996) across networks.

Integration Paths

Integration paths highlight the strategic importance of not only the demand for specific transformation activity outsourcing and transportation service procurement but also of the overall design of the global transportation network in establishing and maintaining the supply of shared global trade routes to meet the evolving transportation demands of MNCs. An integration path is the network overlap with potential value to either or both networks. Integration paths are shaped by the path dimension and the strength of its overlap. These integration paths, being contingent upon the type of network interdependence, determine the network integration requirements.

There are two dimensions of integration paths; location and route. Location refers to overlap in network nodes whereas route refers to the overlap in network linkages. The global transportation network is comprised of a set of paths (i.e. trade routes) with location (nodes) and route (linkages) attributes. Value chains have similar nodes and linkages. Value chain nodes are the geographic location where specific goods transformation activities are conducted. Linkages, however, encompass a subset of locations and routes of the global transportation network for a specific value chain path.

There are four integration path possibilities; 1) no integration path value, 2) location integration value, 3) route integration value, and 4) path (location and route) integration value. Network centrality as a measure of the strength of integration paths adds the value dimension. Degree centrality measures the directness of network intersections by counting the number of routes associated with a location and the number of locations connected to that route. Closeness centrality measures the indirectness of network overlap by counting the number of locations and routes associated with an integration path. Betweenness centrality measures the optimal design of locations and routes for each network by counting the number of routes that cross through the each of the locations of these integration paths.

All three types of network centrality are important measures of the value of integration paths. Since direct and indirect integration path carry equal weight in measures of degree centrality, closeness centrality can prevent a focus on direct paths at the expense of indirect ones (Hansen, Podolny & Pfeffer, 2001). By focusing on the linear reach of the network, closeness centrality suggests that peripheral locations and routes can be stronger when there are fewer direct paths (Burt, 2000). Since network connections have also been found to be more sensitive to functional distance (i.e. spatial features facilitating/inhibiting interaction) than they are to linear reach (Monge & Kirste, 1980), betweenness centrality can further solidify the value of integration paths. In doing so, new integrative network designs can be created for each network based on incomplete location and route overlap or variation in functionality of these paths.

Integration Requirements

The integration requirements of these large interconnected networks are equally important to the competitive performance of disaggregated value chains as are the requirements inherent in the value chain. There are three types of integration requirements; transactional, functional, and structural. Transactional requirements refer to the procurement of transportation services at a market price.
Functional requirements are cooperative arrangements of cross network members performing complementary activities that cannot be decomposed into independent activities without destroying the value of the output (Simon, 1996). Structural requirements refer to design specifications for integration network designs that generate value for the end consumer. These integration requirements are derived from the relational attributes of the network connections; type of network and strength of cross network connection.

There are two types of networks; closed and open. A closed network seeks to maximize network connections by building relationship density within the network between independent firms with complementary processes who voluntarily arrange to consolidate or employ shared resources and capabilities (Ahuja, 2000) to their mutual advantage (Coleman, 1988; Walker, Kogut, & Shan, 1997). Conversely, an open network seeks to maximize network disconnections by bridging structural holes so that strategic advantages can be achieved across dissimilar networks (Burt, 1992). The value derived from open networks arises from building integration paths through bridging relationships that link disconnected clusters of location and route activities across networks. Closed network value arises by capitalizing on the established integration paths through closure relationships that bring complementary activities (i.e. transformation and transportation) within the realm of one network.

The strength of cross network connections can be strong or weak. The heterogeneous characteristic of weak ties expose network members to new skill sets and information by bridging the chasms between network clusters with which there is typically little or no other interaction (Burt, 1992; Granoveter, 1973). Weak ties, therefore, are an effective diffusion mechanism since they can connect cross network clusters, span the periphery of the two networks, and extend into new networks. Conversely, the homophilous characteristics of strong ties are required for the technical and cognitive processes involved in transforming redundant activities into new activities or in transferring them from one application to another. Since the focus is on developing trusting relationships among network partners, strong ties tend to be an effective collaborative mechanism.

There are four types of network connections; 1) cross network diffusion, 2) cross network collaboration, 3) within network diffusion, and 4) within network collaboration. Transactional integration requirements involve cross network collaboration as value chain partners individually procure transportation services for their boundary spanning activities. Functional integration requirements involve the incorporation of a set of transportation services provided by the global transportation network into an MNC value chain such that there is within network collaboration. Structural integration requirements have both collaborative mechanisms so that value of existing integration paths can be maximized and diffusion mechanisms that expose MNCs to new cross network location and routes so they can adapt to evolving global business conditions.

**Integration Value**

Integration value refers to the ability of MNCs to generate a competitive advantage from integrative network designs. This value arises from developing value chains into strategic resources that are supported by dynamic capabilities such as the global transportation network. Integrating the design of the two networks. There are three types of value created from network integration; 1) economic value added, 2) temporary strategic resource advantages, and 3) sustainable strategic resource advantages. Economic value added doesn’t focus on strategic resource advantages but rather on the output, with the output value equal to the value of an input plus the value of the transformation (Christopher, 1993). Transportation activities are viewed as another transformation outside the firm’s control. Temporary strategic resource advantages arise from the continuous improvements in the efficiency of existing integration paths. Transportation, in this case, is a set of linkage activities along the value chain that move materials from one set of transformation activities to another. Sustainable strategic resource advantages arise from the ability to redesign value chains to meet evolving market conditions through the development of new integration paths. The global transportation network is a dynamic capability that builds and reinforces strategic resource advantages attained from existing value chain paths by reconfiguring the design of these paths.
CONTINGENCY FRAMEWORK

The value of network integration, being derived from integration requirements, is contingent on the type of network interdependence. Since the effects of integrative network designs on the competitive performance of MNCs depend on the nature of the competitive environment in which they operate, the structural contingency approach (Thompson, 1967) is used to identify the relationship between the two networks. The basic premise of contingency theory is that structures designed to fit environmental requirements will be more successful than those that are not designed to do so (Pfeffer, 1982).

The contingency framework presented in figure 1 investigates the conditions that lend themselves to differences in network integration. Integration paths shape the integration design requirements whereas integration value arises from the capacity of each network to build and sustain competitive advantages from these requirements. Different types of network interdependence, by shaping integration requirements through an emphasis on different dimensions of integration paths, create variability in the competitive performance of the value chains of MNCs.

Pooled Interdependence

Pooled interdependence (Thompson, 1967) occurs when autonomous network activities contribute to the overall performance of the network through their individual performance. Under these conditions, network integration is low because each network is seen as performing two distinct functions that separately contribute to the transformation of raw materials into finished goods along a given industry value chain. The global transportation network provides a shared pool of transportation services to MNCs for an agreed upon price. Since these services are seen by MNCs as a necessary cost of disaggregated value chain activities, network integration is not addressed. There is no perceived value in doing so. The focus of network integration lies instead in cross network brokerage that matches the demands of MNCs with the available supply of transportation services.

In viewing within and across networks integration as market exchanges suggests that pooled network interdependence has transactional integration requirements in which the cross network relationship is that of buyer/supplier (Douma & Schreuder, 1993). Network integration, then, requires each MNCs to individually procure transportation services from the global transportation network for their boundary spanning activities. Transactional integration requirements, in following the principles of scientific management that break activities into small, manageable tasks (Slack et al., 1995), highlight the efficiency gained from this autonomy (Grubbstrom, 1995; Koskela, 1992; Slack et al., 1995; Starr, 1966; Walrus, 1952). Network integration, under conditions of pooled interdependence, involves cross network coordination mechanisms such as market pricing so that independent firms with weak ties can bridge the two networks for the sale and procurement of transportation services.

Proposition 1a: There is a positive relationship between pooled interdependence and the transactional integration requirements for the global transportation network and MNC value chains.

While value is not explicitly considered, the transactional integration requirements of pooled interdependence follow the prevailing idea of economic value added. Economic value added in a closed network equates to cost minimization rather than to competitive attributes. The underlying assumption is that transformation activities are the most important and, therefore, a requisite to shield from erratic environmental conditions through physical or organizational buffering (Slack et al., 1995). Under these conditions, the cost of entire value chain is minimized by the minimizing the cost of each activity. Within network design improvements occur only when the benefits of individual activity improvements exceed their implementation costs (Hall et al., 1991).

Network relationships are managed as externalities and therefore can be as stable or erratic as market conditions. Since the cost of transportation services are shaped by the market conditions under conditions of pooled interdependence, the economic value added from transportation activities is closely related to its procurement costs. The value of the global transportation network is assumed to be equal to the cost of the transaction since the nature of these transaction costs, being external to each firm, assumes
that the value added is built into the market price of the services. Conditions of pooled interdependence, therefore, do not lend themselves to the type of network integration that focuses on role of strategic attributes in building and reinforcing competitive advantages.

**Sequential Interdependence**

Sequential interdependence exists in a long-linked environment as a system “of successive stages of production [with] each stage of production us[ing] as its inputs the production of the preceding stage and produc[ing] inputs for the following stage” (Thompson, 1967). Under these conditions, value chains are viewed as processes with discrete operational stages of transformation activities performed by MNCs and with the flow of materials between these stages (Shingo, 1988) being the transportation services provided by the global transportation network. Since this condition maintains that the two networks are functionally interrelated, there is a need to integrate the two sets of activities under a single network. As such, the transportation activities associated with each value chain are considered strategically necessary linkages and are incorporated into design of MNC value chains as the routes between transformation activity locations. The global transportation network, then, is not a separate network but rather the sum of the routes associated with all MNC value chains.

Proposition 2a: There is a positive relationship between sequential network interdependence and the route dimension of path integration of the global transportation network and MNC value chains.

An integration focus on routes suggests that sequential interdependence involves a partnership of complementary transformation and transportation activities that serve the same function. While these shipper-carrier partnerships have remnants of transactional integration (Evers & Johnson, 2000; Holcomb & Manrodt, 2000; Lu, 2003), functional integration requirements take precedence over the transactional ones. As the disaggregation of value chain activities has grown, the associated transportation activities have become at least as critical to the functioning of MNC value chains as are the transformation activities. These functional integration requirements lend themselves to the effective inventory management and control (Alderson, 1957; Anupindi & Akella, 1993; Cachon & Fisher, 1997; Garg & Tang, 1997; Stank & Crum, 1997; Stenger, 1996; Tracey, 2004), production planning and scheduling (Graves, et al., 1998; Kruger, 1997; Lederer & Li, 1997; Levy, 1997; O’Brien & Head, 1995), and information sharing and coordination (Fisher & Raman, 1996; Gavirneni, et al., 1998; Lee, et al., 1997; Mason, et al., 2003; Moinzadeh & Aggarwal, 1997) as within network collaboration mechanisms. Network integration, under conditions of sequential interdependence, requires such functional collaboration with strong ties between transportation service providers and their transformation activity partners.

Proposition 2b: There is a positive relationship between sequential interdependence and the functional integration requirements for the global transportation network and MNC value chains.

Functional integration requirements shift the locus of control over transportation activities away from the global transportation network and toward collaborative partnerships between transportation service providers and MNCs. These partners cooperatively manage existing value chain paths by focusing on value chain location and routing decisions. Location decisions depend on the attractiveness of a geographic location to a given transformation activity (Porter, 1990) whereas routing decisions depend on the attractiveness of a set of transportation nodes and linkages to the movement of goods between these activities. The functional integration requirements that follow the simplification and flexibility principles espoused by TQM have made it necessary to include both transformation and transportation activities into existing value chain path decisions for the purpose of eliminating non-value-added activities and reducing lead time along the entire value chain. Functional integration, therefore, may lead to competitively superior (i.e. quality, timing and cost) value chain designs with the potential to become a strategic resource. These advantages, however, are temporary since a functional focus does not consider the structural integration requirements (Sitkin, 1994) that enable these routes to be redesigned based on changing global conditions.
Proposition 2c: There is a positive relationship between functional integration requirements under conditions of sequential interdependence and the potential of value chain paths to become strategic resources that give rise to temporary competitive advantages.

Reciprocal Interdependence

Reciprocal interdependence (Thompson, 1967) occurs in an environment where products and services are customized based on a unique set of requirements. Putting these requirements at the center of the design necessitates high levels of interaction appropriate for interfaces with iterative patterns of interaction with mutual adjustment across networks. Under these conditions, the paths (i.e. locations and routes) of each network are designed based on supply and demand conditions of both networks. Demand conditions refer to the current and expected growth in global markets as well as specific changes in local consumption patterns. Supply conditions refer to the anticipated changes in the location of transformation and transportation activities and the routes associated with such activities. Supply conditions, therefore, are dependent on the path designs of each network, with each network influencing the other. These conditions along with the collective designs of MNC value chains shape the patterns of trade and thus determine the design specifications of the global transportation network (i.e. location of the transportation service hubs and general trade routes available to MNCs for commercial purposes). Similarly, the capacity of the global transportation network, along with market conditions, influences the value chain designs of each MNC. (i.e. a specific set of value chain transformation location and transportation routing decisions). Therefore without path integration along both the location and routes dimensions, MNCs would either be unable to disaggregate their value chains or incur significant costs in doing so under conditions of reciprocal interdependence.

Proposition 3a: There is a positive relationship between reciprocal interdependence and the location and route dimensions of path integration for the global transportation network and MNC value chains.

Research on social network analysis indicates that conditions of reciprocal interdependence have a strong influence on formal and informal network structures (Brass, 1994; Lincoln, 1982; Stevenson, 1990) and on the physical proximity of network activities (Allen, 1977; Monge et al., 1985). This indicates that even though each network is performing a unique set of equally important activities with discrete operational stages (nodes) and flows (linkages), the intensity of interaction across networks in the performance of these activities requires a high degree of cross network design adjustment so that there is significant overlap in location and routes dimensions of the paths each network. Structural integration requirements call for a high degree of path integration along both dimensions. Additionally, cross network diffusion and coordination mechanisms involving a combination of both strong ties to improving existing path integration and weak network ties to develop new integration paths enables MNC continuously reconfigure their value chain path designs to meet the expected patterns of supply and demand across global markets. As value chain activity disaggregation and the geographic distance between these activities increases, the intensity of structural interface and adjustment between the two networks will increase along with the importance of the global transportation network to adapting the design of value chain paths to changing global conditions. Integration requirements, under conditions of reciprocal interdependence, focus on the structural overlap of the two networks as a whole.

Proposition 3b: There is a positive relationship between reciprocal interdependence and the structural integration requirements for the global transportation network and MNC value chains.

Under conditions of reciprocal interdependence, there is a positive relationship between the capacity of MNCs to attain and sustain a competitive advantage and structural integration requirements that shape the design of value chain paths (i.e. locations and routes). The routes of MNC value chains, when consolidated, develop into a separate network of geographically dispersed transportation nodes and linkages that extend beyond their functionality to any given value chain. The consolidation of these routes over time comprises the multimodal hubs and trade routes of the global transportation network. Since these paths have both location and route dimensions, the design and expansion of the value chain paths depends on 1) the geographic location of and distance between transformation activities of each value chains, 2) the geographic location of and distant between transportation activities of the global
transportation network, and 3) the degree of path integration across the two networks. This suggests that the same structural forces that influence the competitive nature of global transportation network paths also influence those of MNC value chains.

Accordingly, the location and route advantages and disadvantages of MNC value chain paths are likely to be amplified by similar advantages and disadvantages of the global transportation network. Structural integration requirements focus on path design with integration mechanisms such as 1) bridging relationships that maximize location and route disconnections so that advantages or disadvantages can be understood followed by 2) closure relationships that maximize network connections through path integration or disintegration. This enables the path advantages of global transportation network to support those of MNC value chains and allows MNCs to mitigate the damage that its path disadvantages may have on value chains. It further enables value chain path disadvantages to be overcome when the global transportation network develops a location and/or route advantage that can be transformed into a new or redesigned value chain path. Structural integration of the two networks, therefore, enables the global transportation network to become dynamic capability that produces direct advantages for itself and indirect strategic resource advantages to MNC value chains. Structural integration requirements, under conditions of reciprocal interdependence, may be a strategic imperative.

Proposition 3c: There is a positive relationship between structural integration requirements under conditions of reciprocal interdependence and the actualization of value chain paths as strategic resources that give rise to sustainable competitive advantages.

DISCUSSION

The scale and scope of value chain disaggregation, its geographic separation from the respective global markets, and the value creation designs that arise from linking these activities together is influenced by the capacity of global transportation network to provide the connectivity infrastructure for MNC value chains. As this network becomes more complex, its cyclical effects on structural integration requirements will continue to increase. The relative price fluctuations and co-movement of goods across borders will, over time, stabilize, thereby making the volume and patterns of global goods mobilization and their associated costs more predictable (Ravn & Mazzenga, 2004). Until this occurs, however, the influence of the global transportation network on value chain performance will remain high.

This paper makes several contributions. First, it provides the theoretical framework from which to study the design integration of the global transportation network and MNC value chains. Effective integrative network designs arise from a solid conceptualization of integration requirements that include path integration and structural contingencies. This framework makes a distinction between the transformation and transportation activities of each network while recognizing their path interrelationship and the contingent nature of this interdependence. This suggests that path integration can have temporal, industry, and geographic limitations that can lead to differential competitive performance between MNCs, even with the same integration requirements, because of the variation of the location and routes associated with transformation and transportation activities. The contingent nature of network interdependence further suggests that strategic resource advantages can vary, even with similarity in path integration across the two networks.

This framework suggests that the resulting reciprocal interdependence between networks may require a social network analysis. Collaborative relationships such as partnerships, joint ventures, strategic alliances, and R&D consortia (Miles & Snow, 1986, 1994, 1995; Galbraith, 1995) have led to a more prevalent use of social networks since these structures are presumed to facilitate the integration of capabilities, information and knowledge across organization boundaries. Executives, however, have paid less attention to these social networks when analyzing reciprocal interdependence than they have on the formal coordination mechanisms that are more conducive to pooled and sequential interdependencies. Social network analysis is used in this study to illustrate that integrative network designs, given the reciprocal nature of network interdependence in a global environmental, have structural components that facilitate network design flexibility.
Strategy literature has focused on the attractiveness of locations to transformation activities (Porter, 1990; Swamidass & Kotabe, 1993). It has not, however, investigated these location decisions as part of an integrative network design. Transportation activity location and route decisions have been internalized within MNC value chains as route decisions. Identifying the network location overlap can add another dimension to location decisions that can enable a more expansive study of the competitive value of specific outsourcing decisions and, in general, the design of disaggregated, geographically dispersed value chains.

Lastly, this framework can be used to explain differences in the conclusions about the global performance of MNCs (Delios and Beamish, 1999; Geringer, Tallman & Olson, 2000; Hitt, Hoskisson and Kim, 1997; Lu & Beamish, 2004; Sullivan, 1994) by indicating that increases in transaction costs as firms establish themselves in a region (Bergh & Lawless, 1998; Denis, Denis, & Yost, 2002; Hill & Hoskisson, 1987; Jones & Hill, 1988; Tallman & Li, 1996; Williamson, 1975; 1985) are not only the result of temporary cost increases in transformation activities but also of permanent increases in transportation costs. Transaction costs, therefore, can be more accurately predicted when transformation outsourcing decisions are tied to the global transportation network.

There are a number of limitations that should be pointed out. First, this study investigates integrative network designs from the perspective of MNCs. This focus was essential in identifying the strategic relevance the integration paths and design requirements to MNCs in today’s global business environment. Future research focusing on the effects of network interdependencies, integration paths and design requirements on the global transportation network would provide a complementary set of tools for shaping the global transportation service sector.

Second, this study sheds light on the design integration requirements and the dimensions of integration paths that enable MNC value chains to be redesigned but provides few details on how to operationalize these constructs. Future research extending this framework could include developing qualitative and mathematical models, operationalizing these constructs and empirically testing them in a global context.

Lastly, since the resource-based view points to the role of firm-specific resource configurations in differential competitive performance, each MNC associated with the same value chain may have unique and shared network interdependencies. Given that the reciprocal network interdependence in the current global business setting has led to unique and shared location and route dimensions of paths across networks, the value configurations for each firm associated with the network may vary competitively, functionally, geographically, and/or temporally. Therefore, it is important to also understand the role of other firm-specific attributes of network design integration so that they can be incorporated into this framework.

The theoretical framework developed herein indicates that the fit between design integration requirements and their corresponding competitive value, in a global environment, lies in investing in integrative network designs while also supporting the existing relationship configurations between the two networks. The integration paths derived from the relational attributes of each network indicate that cross network influences arise from the degree of overlap between the networks and how much this overlap is required. The performance of both networks, therefore, is influenced by the fit between integration requirements and integration paths. Value chain designs are influenced by structural capacity of national and regional transportation ports/hubs and their corresponding configuration of multimodal services. Similarly, the design of the national, regional and global transportation sectors is influenced by the location and routing requirements of disaggregated global value chains. Since integration at the design level facilitates the development and refinement of the location and routing dimensions of integration paths, integrative network designs can have substantial long-term effects on the economic performance of MNCs and their patterns of trade throughout the world. The integration of the global transportation service sector with the value chains of MNCs, therefore, is a strategic imperative.
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Petersen, Ragatz, and Monczka (2005);


TABLE AND FIGURES

Table 1
Literature Review

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<td>Firm Focused Strategies and Tactics</td>
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<td>(Bougoni et al, 1999); (Glasoe &amp; Kehlweber, 2004); (Cartier &amp; Ferrin, 1995)</td>
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Figure 3
Contingency Framework for Integrative Network Designs

Pooled

Sequential

Reciprocal

Network Interdependence

Integration Paths

Integration Requirements

Integration Value

Routes

Functions

Structural

Dynamic Capability

Transaction Resource

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