
Research paper

Supply chain integration: exploring product and environmental contingencies

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Abstract

Purpose – This conceptual paper aims to examine the notion that supply chain integration is an extension and application of vertical integration theory.

Design/methodology/approach – The paper initially defines a foundation in the supply chain and vertical integration literature, with particular attention to the seminal works of Harrigan in vertical integration and Hayes and Wheelwright in product life cycles. The paper then offers an assessment of the state of the supply chain integration literature. Subsequently, the stage of product/process life cycle and environmental variables such as complexity and munificence are examined in detail and are the basis for the theoretical model and propositions.

Findings – This study argues that the stage of life cycle variables is associated with the various dimensions of supply chain integration, and that environmental complexity and munificence have significant moderating effects on the relationships. The paper posits that, for efficiency and success, a strategic fit must exist between environmental, strategic and operations variables, and that specific dimensions of integrative effort are appropriate for given situations. That fit would attenuate bullwhip inefficiencies, either of inventories and other mechanical decisions, or of the less tangible human and structural interaction.

Originality/value – As such, this paper represents a cross-functional and interdisciplinary approach to operations and strategic management theory by identifying and facilitating appropriate operations decisions pertaining to the contingencies of the supply chain.

Keywords Supply chain management, Integration, Vertical marketing, Product life cycle, Environmental management

Paper type Conceptual paper

Introduction

Arguably, development of the integrated supply chain is the most significant contribution to the delivery of goods and services in the past decade. Evolving from the economic theory of vertical integration (Harrigan, 1985) and the operational theory of product life cycle (Hayes and Wheelwright, 1979a, b), supply chain management has been a major source of competitive advantage in the USA and, increasingly, in the global economy. By minimizing the economic costs of manufacturing and delivery and maximizing customer service across numerous stages of production and distribution, supply chain management activities have squeezed costs and redefined the competitive edge in many industries. More succinctly, supply chain efficiency is increasingly the source for competitive advantage.

Vertical integration, the precursor of supply chain integration, is a long-held and central precept of management theory. Corporations in numerous environments, including the transportation, energy, and

communications industries, have benefited from vertical integration for at least a century. The theory is supported by various rationale, including the economies of prorating management and overhead costs across more serial stages of production and distribution processes, and the efficiencies of standardized communication protocols among these activities. Further, vertical integration may result from the need to stabilize quality or quantity, or to manage process flows of costly or risky technologies, facilitating more efficient, standardized, high volumes.

This paper pursues the notion that supply chain integration is an extension and application of vertical integration theory; it models the variables of an integrated manufacturing and distribution supply chain. We examine the relationships between stages of product life cycle and supply chain integration, as well as the moderating effects of environmental munificence and complexity. Specifically, the following research questions are addressed:

- How does the stage of the product/process life cycle affect the degree, breadth and stages of supply chain integration?
- To what extent do the environmental variables of complexity and munificence moderate that relationship?

These issues are important because bad management decisions (or strategic misalignments) are a major

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contributor to supply chain integration inefficiencies or failure (Agarwal, 1997).

This paper is structured as follows. We first present a literature review to identify the conventional definitions of supply chain integration, followed by the underlying theory of vertical integration and a multiple construct of the supply chain. Then we identify and describe the stages of the product/process life cycle. Subsequently, we build on the work of Harrigan (1985) and Hayes and Wheelwright (1979a, b) to posit an integrated theoretical model of supply chain integration and propose-related hypotheses. Finally, this paper concludes with implications for researchers and practitioners.

Literature review

Heskett (1977) was among the first to anticipate and identify the contribution of logistics integration toward improved corporate performance. Previously, integration had emphasized financial influence, corporate diversification, and evaluation and control of environmental factors. However, by the early 1980s, firms turned their focus on efficiency and supply chain integration (LaLonde, 1994). Supply chain integration initially emphasized local optimization of separate activities (Reyes *et al.*, 2002). But, optimization of one stage could notably impact other stages, thus, the “bullwhip effect” (Lee *et al.*, 1997), which emphasizes balance of the entire supply chain. Lummus *et al.* (1998) add other reasons to balance the supply chain:

- increasing global competition forces extraction of supply chain efficiencies; and
- increasing specialization of products and processes has generated an inefficient or disintegrating effect, which must be counterbalanced by greater integration.

Recent studies have also underscored the multi-faceted and complex nature of the supply chain (Akkermans *et al.*, 1999; Cooper *et al.*, 1997; Mejza and Wisner, 2001). Following Cooper *et al.* (1997), Mejza and Wisner (2001) identify three basic supply chain decisions:

- (1) number and type of business processes to integrate;
- (2) horizontal and vertical network; and
- (3) management processes used.

Certainly, supply chain management today is more than the coordination of logistics, and enhanced efficiencies of supply chain integration are central to success.

Various responses to smooth the exigencies of inefficiency and multi-dimensionality have been put forward. Brewer and Hensher (2001); McAfee *et al.* (2002); Stuart (1997); and Birou *et al.* (1998) have all identified the importance of “fit”, alignment, or consistency in implementation of supply chain of activities. Their logic is that variation from strategic alignment would result in inefficiencies of cross-functional interaction, or the behavioral equivalent of the “bullwhip effect”. Still, others have posited that competitive priority (Stonebraker and Liao, 2003) and product life cycle (Birou *et al.*, 1997, 1998) may be notable explanatory variables, and several other recent studies have considered process components (Marsh *et al.*, 1997; Ryan and Riggs, 1996).

Life cycle has been widely used as an explanatory model of business process evolution. Although initially defined in a marketing context (McNair, 1958; Levitt, 1965), life cycle has been applied to a variety of manufacturing (Hayes and

Wheelwright, 1979a, b), purchasing (Berenson, 1967; Ellram, 1991a, b; Ellram and Carr, 1994), manufacturing cells (Marsh *et al.*, 1997), and international (Onkvisit and Shaw, 1983) contexts, underscoring the range and complexity of the notion. The basic premise is that business processes evolve, like biological species, through a series of life cycle stages from birth to death, with each stage engendering clearly defined and relatively stable characteristics.

Despite this extensive probing in supply chain integration and in life cycle processes, a cross-disciplinary operational model of life cycles contingencies and supply chain management has not emerged. In fact, the supply chain continues to be a multi-faceted, segmented, and extremely complex process, which today is essentially bereft of theoretical underpinnings. Yet, both local businesses and global corporations are increasingly dependent on such theory as they improve and put into operation integrated supply chains. Unfortunately, however, as the field has evolved, no construct has been put forward to clarify life cycle contingencies under which supply chain integration would be appropriate or how environmental variables would contribute to or hinder the process.

Conventional definition of the supply chain

The concept of the supply chain, identified in 1985 by Houlihan (Cooper and Ellram, 1993), suggests a “process for building improved and stronger upstream and downstream business linkages” (McAfee *et al.*, 2002, p. 1), focused toward improving value for the ultimate customer (Lummus *et al.*, 1998). Related definitions of the supply chain include: “how to integrate and perform logistics and manufacturing activities” (Pagh and Cooper, 1998, p. 13), or more generally, collaboration among supply chain partners. A more elaborate and applied definition is: “the connected series of activities concerned with the planning and controlling of raw materials, components, and finished products from suppliers to the final customer” (Vickery *et al.*, 1999, p. 16). Minimally, then, as pointed out by Akkermans *et al.* (1999), the characteristics of a supply chain must include multiple echelons, focus on integration, and goals of service and profitability, and may also involve collaborative processes and value-adding considerations.

Supply chain flows are both forward and backward. Products, often enhanced with a variable service bundle, flow forward while information flows backward (customer demand requirements - design and volume), as well as forward (promotional information and availability). Cash and credit movements are also part of the integrated supply chain flows. Thus, the supply chain emphasizes non-ownership and the lesser formality of applied linkages at all stages, whether the firms are large or small. Unfortunately, the process is anything but smooth; it consists of a variety of roadblocks and enablers, each with varying efficiencies (Akkermans *et al.*, 1999).

The limit to supply chain integration is best captured in the concept of “focus” (Skinner, 1974), which states that a production activity must focus on one or a small number of products (or product lines), one or a few production processes, and one or two similar technologies. If a production activity attempts too many products, processes, or technologies, it would become “unfocused”, ultimately ceding market share to more efficient, focused processes. This explains, for

example, why a Rolls Royce automobile cannot be built in the same facility as a Ford.

Vertical integration as the foundation

Vertical integration is well established as a foundational concept of strategic management, including contributions by Coase (1937) and Williamson (1975). The advantages of economies of scale and control (Harrigan, 1985) are balanced against the downsides of inflexibility (Vickery *et al.*, 1999). Vertical integration is defined as “a variety of decisions concerning whether corporations, through their business units, should provide certain goods or services in-house or purchase them from outsiders instead” (Harrigan, 1985, p. 397). This definition suggests the classic strategic-, economic-, and large-corporation-based concept of vertical integration. A more recent, applied definition, adapted from Cox and Blackstone (2001) is: the degree to which a firm decides to produce in multiple value-adding stages from raw material to the ultimate consumer. This latter approach emphasizes management choices and tradeoffs in serial production/distribution activities.

Harrigan (1985) argues that vertical integration is not unidimensional; rather, vertical integration applications display varying breadth, stages, degrees, and forms. Breadth is “the number of activities that firms perform in-house at any particular level of the vertical chain” (Harrigan, 1985, p. 401). Degree is the percent of total production exchanged with sister units. Stages refers to “the number of steps in the chain of processing which a firm engages in – from ultraraw materials to the final consumer” (Harrigan, 1985, p. 400). Form, the final dimension, means ownership or quasi-ownership of the integrative mechanisms of control, including such quasi-ownership mechanisms as share ownership, capital underwriting, and ownership of other stakes in the company, as well as long-term contracts and other leveraging activities (Harrigan, 1985). However, in application, the form of integration becomes a more subtle, qualitative, informal, highly categorized and dynamic variable, for which a suitable continuous dimension has not been defined. For that reason, this paper does not further evaluate the form dimension of vertical integration.

As might be expected, there is notable correspondence between the strategic precept of vertical integration and the logistics notion of supply chain integration. Certainly the concepts of consistency of organization culture and policies (McAfee *et al.*, 2002), of organizational fit (Stonebraker, 1986) or alignment (Birou *et al.*, 1998), and of complementarities of various components of the organization strategy (Brewer and Hensher, 2001) exemplify this correspondence. Further, integration or disintegration may be highly dynamic and may vary at different stages of supply chain activity (Murphy *et al.*, 1998), as well as over time. Table I classifies these emphases of vertical integration and supply chain integration to demonstrate that supply chain integration is an evolving and applied elaboration of the more theoretical concept of vertical integration.

The supply chain as a multidimensional construct

Recent studies (Mejza and Wisner, 2001; Akkermans *et al.*, 1999) conclude that supply chains more resemble a multifaceted umbrella than a univariate construct. In addition to goods and a varying bundle of services, supply chains transfer a range of information on product/service attributes, cost, and

availability. Further, supply chains may necessitate a commonality of volumes, quality, and technologies to assure efficiencies of flow and communication. Several studies find associations of the product life cycle stage with functional decision-making activities, either generally (Ayres and Steger, 1985; Birou *et al.*, 1998; Ryan and Riggs, 1996), or in a discipline specific context (Birou *et al.*, 1998; McAfee *et al.*, 2002). Still other studies identify the impact of market entry and exit strategy on survival (Agarwal, 1997) or ability to innovate (Klepper, 1996).

Ultimately, successful supply chain integration efforts will likely be tied to a wide range of cultural variables and professional functions. Bagchi and Virum (1998) conclude that successful logistics alliances involve an atmosphere of openness and trust and a clear communication lines. Additionally, Brewer and Hensher (2001) find, in a canonical evaluation of 20 logistics organizations, a strong complementarity between a logistics strategy and various key business processes, including operations, inventory, customers, and information technology, suggesting a strategic convergence that results from the focus of the organization. Other contributions, including Akkermans *et al.* (1999), Cooper and Ellram (1993), Ellram (1991a, b), and Sanders and Premus (2002), consider cultural and organization variables as related to supply chain effectiveness.

A supply chain often involves five stages: creation of raw materials, manufacture of parts and components, assembly of finished goods, distribution of goods/services, and customer service. Each stage may involve several serial production/distribution steps, and activities likely involve functions of purchasing, operations, and logistics. Flows of information and exchange, including market research, demand forecasts, order flows and cash/credit, as well as design prototypes are included. Further, the risks and costs associated with customer service level and inventory support are differentially defined at each activity. Figure 1 shows the stylized activities of an integrated supply chain, with the Harrigan (1985) dimensions of vertical integration overlaid.

Supply chain integration: the state of the literature

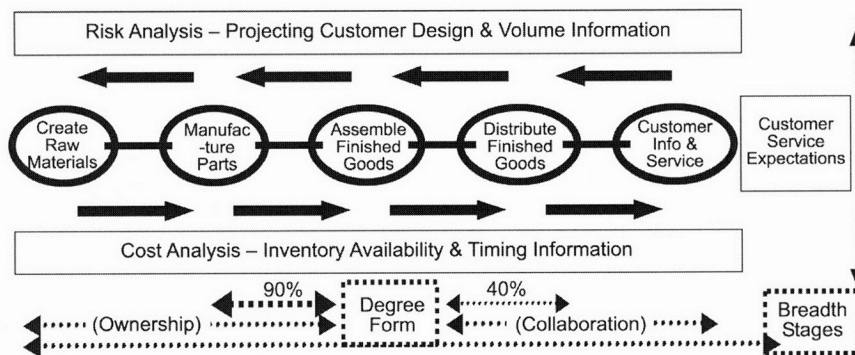
As supply chains have become increasingly sophisticated over the past decade, the literature has concentrated on several interrelated tracks. The classical works, including Harrigan (1985) and Hayes and Wheelwright (1979a, b), followed more recently by Akkermans *et al.* (1999), Bagchi and Virum (1998), and Cooper and Ellram (1993), as well as Ellram (1991a, b), are primarily descriptive in nature and offer some specific elaborations of cyclic impacts, characteristics, and the range and scope of the topic. An adjunct of this track is the description of the historical emergence of supply chain integration, noted by Ellram and Carr (1994), LaLonde (1994) and Reyes *et al.* (2002).

A second major track of supply chain research relates to the notion of integration. Mathematical modeling efforts (Lee *et al.*, 1997; Cohen and Whang, 1997) address the serial or multi-stage efficiencies of supply chain integration, while others (Birou *et al.*, 1998; Brewer and Hensher, 2001; Williams *et al.*, 1997) show the importance of cross-functional coordination toward integration efficiency. Still a third emphasis of this integrative track is focused toward specific disciplines, such as purchasing (Ellram, 1991a, b; Stuart, 1997), information technology (Murphy *et al.*, 1998; Sanders and Premus, 2002), and retailing (Stassen and Waller, 2002).

Table I General classification of vertical integration and supply chain integration

	Vertical integration	→	Supply chain integration
Emphasis	Theory		Application
Original discipline	Strategic management		Logistics management
Functional foundation	Economics, finance		Distribution, communication
Entity	Corporate		Activities or workcells
Entity size	Generally large		Any size
Measures	Efficiency of flow		Smoothness of flow
Integrating mechanism	Ownership, quasi-ownership		Coordination
Process	Control		Collaboration
Rate of change	More static		More dynamic
Paradigm	Consistency Uniformity		Irregularity

Figure 1 A stylized representation of the supply chain



Note: The four Harrigan (1985) dimensions of stages, breadth, degree and form are superimposed in dotted lines

Vickery *et al.* (1999) pursue a third major track by focusing and elaborating the competitive priorities, such as flexibility, arguably the most important priority to supply chain integration.

Thus, the supply chain literature may be generally characterized as:

- describing the emergence and characteristics of the supply chain;
- focused on smoothing and integration, both vertical and horizontal, and either mathematically or conceptually and often from a discipline specific perspective; and
- identifying the competitive priorities and their impact on integration.

However, only a few studies directly address the underlying product life cycles (Cohen and Whang, 1997; Birou *et al.*, 1997) which integrate the product/process/industry environment, and none relate the product life cycle stage to appropriate integration decisions.

Further, there is no consideration of the moderating environmental impacts. Yet, these are specifically the theoretic issues that aggressive business practitioners must consider and apply to manage state-of-the-art integrated supply chains. Thus, the demonstrated relationship between operational, integration, and environmental variables is, at best, tenuous and spotty. Specifically, there is little reliable research that relates:

- The stage of the product or process life cycle to the dimensions of vertical integration.
- The environmental variables of complexity and munificence to either the environmental or vertical integration variables or to the nexus of those variables.

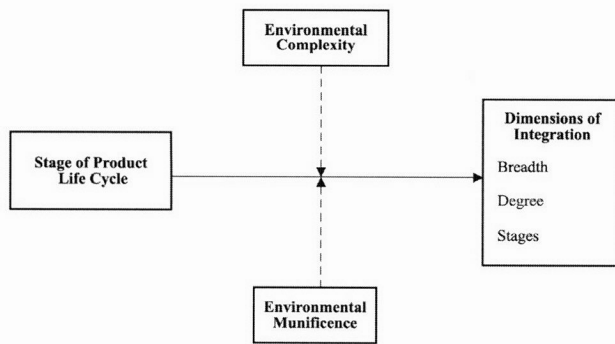
This paper then establishes, based on extant literature and projected intuition, these relationships, both as an integrated model and as a series of hypotheses.

Theoretical model and hypotheses development

Theoretical model

Figure 2 depicts our proposed theoretical model. We argue that the product life cycle stage has a direct impact on the appropriate dimensions of supply chain integration activity (Agarwal, 1997; Klepper, 1996; Birou *et al.*, 1998). Further, we argue that the relationships between independent and dependent variables are moderated by the environmental complexity and munificence (Aldrich, 1979; Dess and Beard, 1984; Keats and Hitt, 1988).

The choices of stage of the product life cycle as the independent variable and the environmental variables of complexity and munificence as a moderating variables are based on the following considerations: first, the stage of the life cycle is a central precept of operations strategy; it is related to process continuity, entry/exit strategies, and risk

Figure 2 An integrative model of supply chain management

and competition in the marketplace (Hayes and Wheelwright, 1979a, b; Agarwal, 1997; Klepper, 1996). Birou *et al.* (1998, p. 44) conclude that the product life cycle, because of its ability to define competitive priorities and other important product/process characteristics is an “ideal tool” for a linking mechanism.

Second, the stage of life cycle relates to and integrates a range of non-operations-management variables including cultural and human resource issues. McAfee *et al.* (2002) and Brewer and Hensher (2001) conclude that, for effectiveness, various human resource and cultural processes should be consistent with the logistics environment, in terms of staffing, training, compensation, and evaluation. Other studies show the centrality of life cycle to retailing (Stassen and Waller, 2002), information technology (Murphy *et al.*, 1998), purchasing (Ellram, 1991a, b; Ellram and Carr, 1994), and international (Onkvisit and Shaw, 1983) contexts.

Third, the life cycle concept characterizes the realistic dynamic evolution of the product, process and industry situation, not afforded by other models. Clearly, product, process and industries are differently defined by the life cycle stages in a way that describes the dynamic evolution, be it rapid or more protracted, of the business decision environment.

Our inclusion of organizational environmental variables as moderators follows the research tradition in areas of strategy and organization theory. Organizational environments represent a major contingency faced by a firm. The environment creates opportunities and threats for an organization and impacts supply chain implementation decisions. It also affects organizational structure, processes, and management decision making (Duncan, 1972; Keats and Hitt, 1988). The decision to integrate vertically or to use non-ownership supply chain integration techniques, or not, is a conscious managerial choice that results from complex internal decision processes. Thus, the relationship between product life cycle and supply chain integration is expected to vary significantly based on external environment conditions.

A long stream of research has studied organizational environment as a multidimensional concept (Aldrich, 1979; Dess and Beard, 1984; Keats and Hitt, 1988). Specifically, the central environmental factors identified in the literature are dynamism, uncertainty, munificence and complexity (Bourgeois, 1980; Dess and Beard, 1984). Dynamism is defined as the degree of change or market stability (Aldrich, 1979; Dess and Beard, 1984). Strategists argue that unpredictable discontinuities in an environment create risk

and difficulty for effective strategic formulation and implementation. We examine the impact of dynamism or uncertainty on supply chain integration in Stonebraker and Liao (2003). In this study, we focus on the other two environmental attributes, complexity and munificence.

Environmental complexity is defined as the heterogeneity and concentration of environmental elements (Dess and Beard, 1984) and is thought to have direct impact on the form of organization structure (Keats and Hitt, 1988). For example, organizational decision makers deal with environmental complexity by structural divisionalization. Divisionalization allows development of specialized knowledge to deal with specific environmental elements and create decentralized decision-making authority to take needed actions to respond to complexity (Williamson, 1975).

Dess and Beard (1984) define “munificence” in terms of resource abundance and resulting capacity to support organizational growth. Munificence refers to an environment’s ability to support sustained growth and the stability of an organization (Aldrich, 1979). Munificence may also affect strategic choices designed to capitalize on environmental opportunities (Keats and Hitt, 1988).

Hypothesis development

The product/process/industry life cycle originates in the biological notion from which it has retained the constraints of irreversibility and inevitability (Ayres and Steger, 1985). The traditional representation of the life cycle includes between four and six stages, with a core of the following four stages: birth, growth, stable state, and decline, stated with some minor terminology variation (Agarwal, 1997; Ayres and Steger, 1985; Birou *et al.*, 1997, 1998; Klepper, 1996; Ryan and Riggs, 1996). Hayes and Wheelwright (1979a,b) differentiate product from process life cycles and suggest industry descriptors for each stage. Additionally, they defined the notion of process continuity, describing the evolution of product and processes on the product/process continuum.

Abernathy and Utterbach (1975) may have been the first to describe the relationship of innovation to product/process development. They find that initial emphasis on product, materials, and service innovation shifts to process technology, information, and management systems innovation at approximately the transition from the growth stage to the stable state stage of the life cycle. For simplicity, these concepts are respectively called “product” and “process” innovation. Ayres and Steger (1985) posit several ways to rejuvenate and extend life cycles including technology infusion and increased flexibility, key characteristics of an integrated supply chain. Ryan and Riggs (1996) conclude that concurrent efforts by design, process, marketing, and production facilitate a rejuvenation of product, process or both, suggesting that a coordinated technology infusion of product or process design can reverse the life cycle by enhancing flexibility. Vickery *et al.* (1999) identify five types of supply chain flexibility. To the classic variety and volume flexibility (Hill, 1994), they add launch flexibility (rapid introduction of many new products and varieties), distribution (access) flexibility, and responsiveness (to target markets) flexibility. Vickery *et al.* (1999) find that volume flexibility is most related to market uncertainty and business performance variables and, further, that launch flexibility is related to uncertainty, again supporting technology or

knowledge infusion as a key component of supply chain integration.

The relationship of market entry/exit decision to stage of product/process life cycle is initially captured by Hayes and Wheelwright (1979b), who describe four strategies:

- (1) the innovator (from start up to stable state);
- (2) the process shifter (from start up to maturity/decline);
- (3) the volume producer (from growth to maturity/decline);
- and
- (4) the blunder (from growth to stable state).

(Note: for clarity, the authors have given these names to the four indicated strategies.) The blunder fails because the firm is not in the market long enough to recover its investment or may have a wrong product or process design. The innovator and the volume producer do not make significant innovation shifts; they represent, respectively, the early (product innovation) and late (process innovation) stages of the life cycle. Without the major innovation shift, they are at less risk of failure, but also have less incentive to initiate a major integration effort. The process shifter, which shifts from low volume flexibility to high volume standardized production, makes the transition from product to process innovation and, thus, has the greatest risk of potential failure, but also the most to be gained from successful integration. Agarwal (1997) finds that non-competitive environments, large size, and diversified firms are associated with lesser risk of life cycle transition failure; and, Klepper (1996) finds that size of the firm is central to the ability to appropriate funds and recommit those to the necessary innovation.

Thus, one supply chain strategy emphasizes the earlier stages of the life cycle with high product cost, low volumes of customized products/services, and limited and complex inventory and process control. A second supply chain strategy involves the later stages and is associated with stable markets, standardized design and volumes, and readily available inventory to achieve customer expectations. The third strategy involves building and managing an effective "early stage" environment, then, as volumes increase and products become more standardized, transitioning to a "later stage" environment. Figure 3 shows the traditional four stages of the product life cycle with commonly used product, process, and industry descriptors, supplemented with the levels and types of innovation infusions and market entry/exit strategies.

In the aggregate, then, the body of research suggests that alignment of life cycle stage with dimension of integration is critical to reduce inconsistency and improve efficiency. Successful supply chain integration, in effect, depends on an investment in process technology and organization flexibility, which extends the life cycle. Brewer and Hensher (2001, p. 18) found "a strong complementarity between logistics strategy and key business practices", including operations and supply chain integration.

For example, the supply chain integration effort of a product/process in the birth or growth stage would be expected to pursue extensive breadth integration because that is more consistent with the lower volume, job shop, smaller competitor, flexibility-focus, and other characteristics of "early stage" life cycles. Thus, "later stage" life cycles are expected to be associated with less breadth. Organizations that select the innovator strategy would be expected actively to pursue a breadth strategy. Based on this rationale, we propose:

H1. As firms move from start-up/growth stages to mature/decline stages, the less the breadth of supply chain integration.

Duncan (1972) contends that managers facing a more complex (i.e. heterogeneous) environment will perceive greater uncertainty and have greater information processing requirements than managers facing a simple environment. Dess and Beard (1984) also suggest that organizations competing in industries that require many different inputs or that produce many different outputs (high complexity) should find resource acquisition or disposal of output more complex than organizations competing in industries with few different inputs and outputs. Consequently, we expect that firms operating in highly complex environments would focus on fewer activities in a particular stage of value chain in order to compete more effectively. Therefore, as firms evolve from early stages to late stages of product life cycle, we would expect the breadth of supply chain integration to be narrower in a highly complex environment than in a simple environment. The greater the environmental complexity, the greater the negative impact of product life cycle on the breadth of supply chain integration. Based on this rationale, we propose:

H1a. The negative impact of increased stage of product life cycle on breadth of integration is greater in more complex environments than in less complex environments.

A munificent environment permits organizational growth and stability, which in turn, may generate slack resources (Cyert and March, 1963). These slack resources can provide a buffer for the organization during periods of relative scarcity, such as the stable state and decline stages of product life cycle. Therefore, we expect that firms operating in a munificent environment would be less compelled to focus on fewer activities in a particular stage of value chain (breadth) as compared to those operating in a scarce environment. Based on this rationale, we propose:

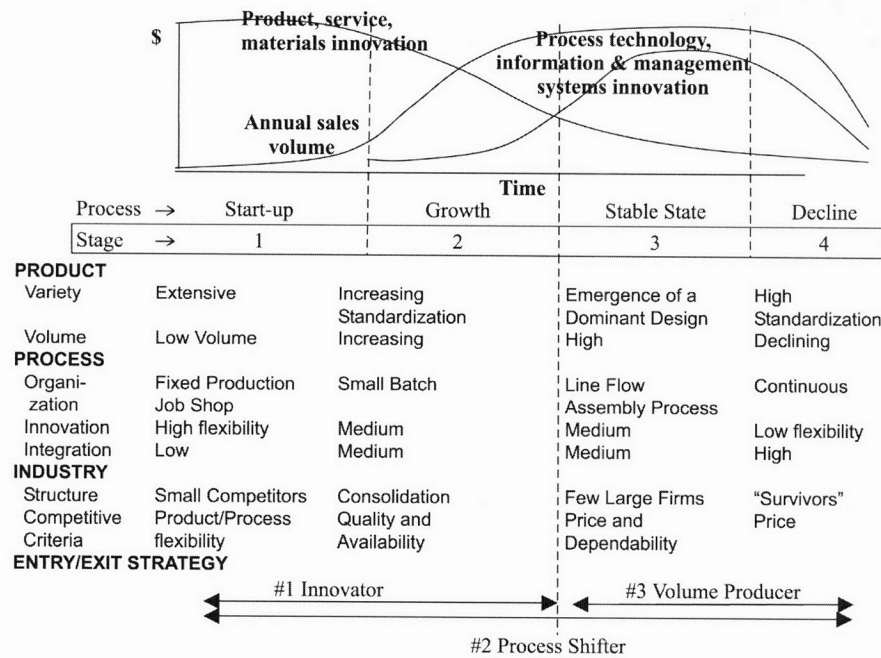
H1b. The negative impact of increased stage of product life cycle on breadth of integration is greater in low munificent environments than in high munificent environments.

As firms move from early to later stages of the life cycle, they would be expected to pursue a greater degree of supply chain integration because those firms are standardizing products and processes toward a dominant design, and consolidating and competing on price in stable markets. Such a strategy would encourage firms in this situation to increase the degree of an already generally inflexible process so that they could more completely benefit from the scope economies of using existing processes to achieve greater volumes. Organizations that select the volume producer strategy would likely pursue a greater degree of integration effort because that strategy would require less cost to be recovered in the short life cycle period available. Based on this rationale, we propose:

H2. As firms move from start-up/growth stages to mature/decline stages, the greater the degree of supply chain integration.

Aldrich (1979) contends that increase in the environment's structural complexity would increase the need for a firm's strategic activities. In more complex environments, firms are more likely to rely on internal transactions to minimize

Figure 3 The relationship of process and product life cycles



Note: The extent of product and process innovation (Abernathy & Utterbach, 1975) and generic entry/exit strategies (Hayes & Wheelwright, 1979b) are superimposed on this diagram

uncertainties of dealing with external suppliers. Moreover, environmental complexity also describes both the number of units that require interaction and the amount of knowledge about products and customers that the manager must secure. For this reason, to assure efficiency and effectiveness, we expect a greater degree of supply chain integration in more complex environments than in simple environments. Based on this rationale, we propose:

H2a. The positive impact of increased stage of product life cycle on degree of integration is greater in high environmental complexity than in low environmental complexity.

In hostile or non-munificent environments, scarcity of resources forces firms to pay greater attention to resource conservation. This effort would, in turn, compel the firm to depend on transactions with other "sister" business divisions (degree). The increased transactions among business divisions within the firm provide much needed resources for survival in a resource scarce environment. Alternatively, when the environment is munificent and resources are abundant, there is less pressure for the firm to transact internally. Therefore, we would expect a greater degree of supply chain integration in a scarce environment than in a munificent environment. Based on this rationale, we propose:

H2b. The positive impact of increased stage of product life cycle on degree of integration is greater in low munificent environments than in high munificent environments.

Finally, as an organization grows from the early stages to the later stages of the product life cycle, it may want to control a greater number of integration stages to manage the efficiency of its supply chain better. This extension of the supply chain to additional stages will likely be more costly than merely

increasing the degree of existing integration efforts; thus, stages would be expected to increase when no further degree was achievable. Further, process shifter organizations would likely pursue a stages integration strategy as they shifted from product innovation to process innovation. Of course, this is a risky decision, however, the firm is simultaneously making several other strategic shifts and would want to achieve consistency as it evolved. Based on this rationale, we propose:

H3. As firms move from start-up/growth stages to mature/decline stages, the greater the stages of supply chain integration.

Organization theorists have extensively studied the impact of the environment on organizational strategy and processes. They emphasize the need for organizations to adapt flexibly or buffer themselves from increasingly turbulent and complex environmental conditions (Thompson, 1967). Firms that face a more complex environment will tend to have a more flexible and simple structural arrangement such as focusing on a few key value chain activities and outsourcing other less important activities. Therefore, when two firms are at the same stage of product life cycle, we expect that the firm competing in a more complex environment will be less likely to be vertically integrated than the firm in a simple environment. Based on this rationale, we propose:

H3a. The positive impact of increased stage of product life cycle on stage of integration is less in highly complex environments than in simple environments.

Relative scarcity of resources in existing markets increases the risk of remaining in those markets and increases the need to expand operation into new markets, thereby reducing dependence on existing domains (Hannan and Freeman, 1977). Thus, firms in less munificent environments expand into markets with more munificent environments as a way to

balance overall risk (Bettis, 1981). Expansion into related markets is easier to achieve than that into unrelated markets, especially considering that related diversification overall would outperform unrelated diversification. Therefore, as a product evolves along its product life cycle from emerging/growth stage to mature/decline stage, a firm is less likely to integrate vertically into other markets in a highly munificent environment, as compared to a firm in a less munificent environment. Based on this rationale, we propose:

H3b. The positive impact of increased stage of product life cycle on stage of integration is greater in low munificent environments than in high munificent environments.

Thus, the innovator is associated with early life cycle stages and is hypothesized (H1) to pursue a breadth integration strategy, the volume producer is associated with the later life cycle stages and is hypothesized (H2) to pursue a degree integration strategy, and the process shifter transitions from early to late life cycle stages and is hypothesized (H3) to be associated with the stages strategy. These relationships and the effects of moderating variables are depicted in Figure 4.

Conclusions and implications

This paper has pursued the notion that, for efficiency and success, a strategic fit must exist between operations, integration, and environmental variables. That fit would attenuate “bullwhip” inefficiencies, either of inventories and other mechanical decisions, or of the less tangible, human interactive sort. As such, this paper represents a cross-functional and interdisciplinary approach to operations and

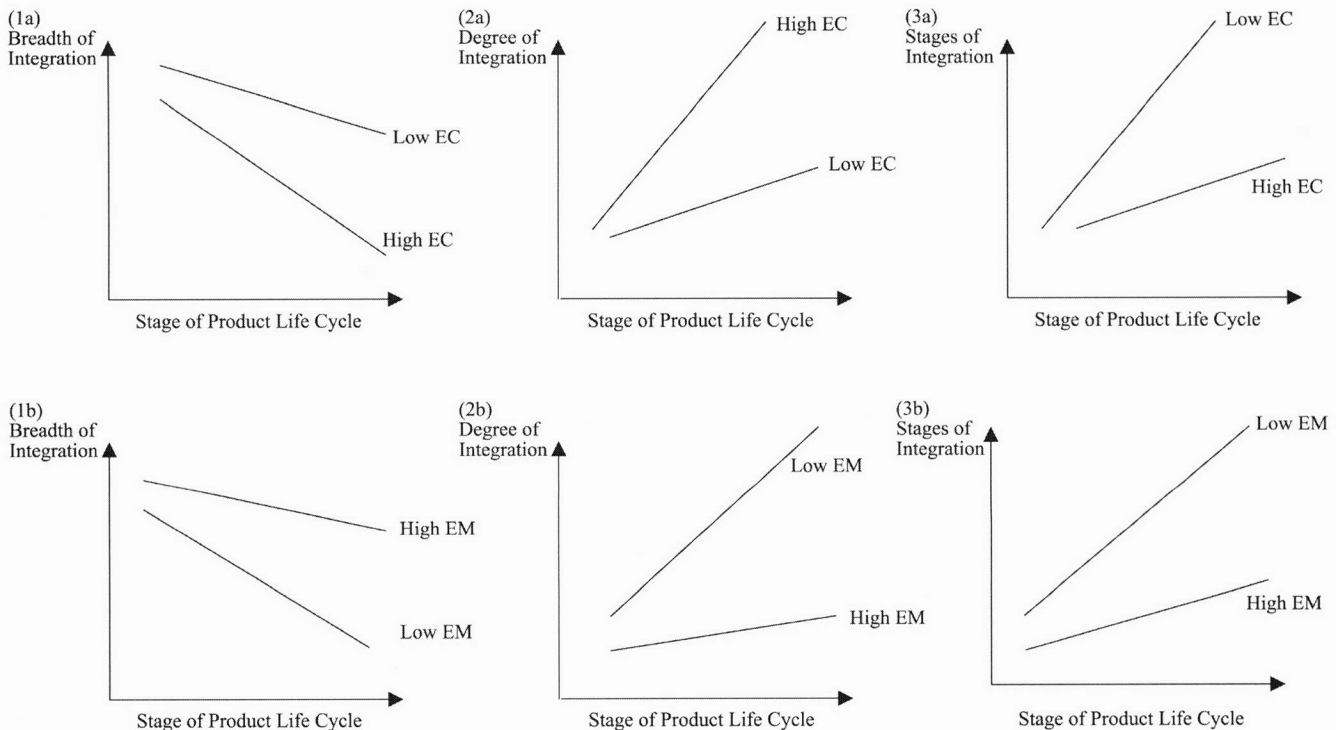
strategic management theory by identifying and facilitating appropriate operations decisions pertaining to the contingencies of supply chain interaction. In that pursuit, this study makes a number of contributions, yet simultaneously it has some limitations.

This study is one of the first to posit and define the relationship between the strategic management notion of vertical integration and the operational concept of supply chain integration. Though there are definitive differences in the focus of these two disciplines and the corresponding research efforts that have emerged, clearly supply chain integration is an applied and operationalized approach of the more theoretical and strategic notion of vertical integration.

Additionally, numerous studies have defined the supply chain and vertical integration variables as unidimensional and static; however, this study, following recent analyses, addresses vertical/supply chain integration as a continuous and multidimensional variable. Further, we argue that stage of the product life cycle determines a firm’s vertical integration strategy, and that impacts are moderated by an environmental complexity and munificence. This research did not find prior studies that have addressed either the relationship of product life cycles to integration variables or the impact of environmental factors as moderators of the relationship between life cycle variables and the integration variables. This study, then, suggests and dimensionalizes the relationships of moderating variables to the primary independent and dependent variables.

This study does, however, have several notable limitations. Of course, this paper has focused on the model building, dimensionalization, and hypothesis-positing activities only.

Figure 4 Stage of product life cycle and integration dimensions, with environmental moderators



Note: EC – Environmental Complexity
 EM – Environmental Munificence

Given that the currently available research focuses primarily toward descriptive and characterization, with some measurement of integration variables, this study is an initial attempt to provide a theoretic foundation and model of the supply chain. It has not developed or operationalized a high-confidence test of the model. That work is yet to be done.

Certainly the omission of several variables, such as the form dimension of integration and the uncertainty and dynamism variables of the environment, detracts from the overall scope of the model. These variables are likely entwined with those of the present study and should be pursued, both separately and in concert, in future efforts. Of course, there is a tradeoff between the preciseness of the definition of a study and the manageability of a study. The more variables that are described, the greater the number of potential hypotheses, and, as the study moves toward empirical testing, the larger and more complex the survey, the sampling processes, and the method.

This study is an example of a cross-disciplinary and cross-functional analysis that is increasingly relevant to the more dynamic and integrated environment of global business. It establishes the foundations for numerous future conceptual and empirical research efforts. The environmental variables of dynamism and uncertainty, as well as the form dimension of vertical integration should be the focus of further conceptual research to establish the nature and strengths of their interrelationships with current study variables. Further, this study begins the process of evaluating and diagnosing situational variables focused toward answering the questions: under what environmental and operational circumstances should management pursue supply chain/vertical integration, at what costs, and with what expectancies for success?

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