# Organizational Flexibility and Inventory Flow Integration

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## Abstract

*The objective of this study is to identify how dimensions of organizational flexibility enable inventory flow integration, evidently an efficiency imperative, across the supply chain. The paper investigates the impact of product modularity, use of teams and IT infrastructure reconfigurability as dimensions of organizational flexibility, on inventory flow integration across the supply chain. Data was collected from 110 supply chain and logistics managers in manufacturing and retail organizations. The results of this study indicate that inventory flow integration, while apparently an efficiency imperative, increases the interdependence of various supply chain linkages and reduces already existing buffers, is enabled by flexibility capabilities in the organization.*

**Keywords:** Organizational flexibility, IT infrastructure, inventory flows

## Introduction

The digital economy is characterized by short product life cycles, and the demand for customized products and services (Sambamurthy and Zmud 2000). The era of hypercompetition requires organizations to compete on several dimensions at once (Ferdows and De Meyer 1990) rather than focusing only on one of flexibility or efficiency (Thompson 1967; Ghemawat and Costa 1993). Organizations now try to be flexible and efficient at the same time (De Meyer et al. 1989; Volberda 1996; Adler et al. 1997). To ensure that the dual demands of flexibility in product mix, product design and volume are met at the same time that the costs for producing each individual unit is minimized is a complex task that requires organizations to maintain capabilities that enable flexibility while improving efficiency at the same time. Flexible organizations forms (Volberda 1996), flexible systems (Duncan 1995) and manufacturing technologies (Gerwin 1993), product variety and process innovation (Rosenkranz 2003) and mass customization (Gilmore and Pine 1997; Zipkin 2001) are capabilities used by organizations to cope simultaneously with rapid delivery of customized products and services at the lowest possible cost (Boynton et al. 1993). Integrating the supply chain from end to end, to minimize inventory holdings enables efficiency and cost reduction in the supply chain, while collaborative logistics management can enable better allocation of inventory and lowering of costs across the supply chain (Cachon and Fisher 2000).

Inventory flow integration can include just in time delivery (Smith and Walter Jr. 2000) and management of minimal inventory holdings (Cohen and Lee 1998; Mabert and Venkatraman 1998) held at optimally located distribution centers (Geoffrion and Powers 1995) across the supply chain. The integration of physical flow of raw materials, work in process and finished good inventory and the optimal staging of inventory at various supply and distribution points enables organizations to optimally match supply and demand signals across the supply chain (Rai et al. 2001).

Inventory flow integration is likely to be enabled by manufacturing (Gerwin 1993) and information technologies (Ellinger et al. 1999; Parekh 2001) that enable rapid information processing and rapid manufacture of low cost standardized products in the shortest possible time through mass production techniques and structures that are organizational bureaucracies (Fisher 1997). However inventory flow integration can also be directed towards flexibility, to the extent that it can enable organizations to minimize inventory holdings to avoid stockpiles of obsolete inventory, and collaboratively manage inventory with suppliers and logistics partners to focus on core competences and ensure rapid responses to changes in demand signals as and when they occur. If organizations need to balance the needs to flexibility and efficiency, albeit to varying degrees based on the demand volatility of their product environments (Fisher 1997), it follows that they need to cultivate capabilities pertaining to both flexibility and efficiency within their organizational, technological and product structures and across their supply chain. While the impact of product characteristics (Baldwin and Clark 1997), and IT (Mehmet et al. 2002) on the supply chain has been investigated separately in various studies, the objective of this study is to integrate these streams of literature to identify how dimensions of organizational flexibility enable inventory flow integration across the supply chain.

This paper investigates the impact of product modularity, use of teams and an IT infrastructure reconfigurability as dimensions of organizational flexibility, that enable organizations to integrate inventory flows across the supply chain. This paper is organized as follows. The first section develops the research model, after summarizing past research on inventory flow integration and organizational flexibility. The next section describes details about the empirical study, including research method, data collection procedures, statistical analysis, and results. We then present and discuss our findings and offer some implications for managers and for future research.

## The Research ModelI

n hypercompetitive environments, there are likely to be multiple sources of uncertainty, from inputs, to product markets and manufacturing processes. Organizations can use a variety of methods to cope with uncertainty ranging from work organization, information technology, product design and manufacturing planning and control processes (Gerwin 1993). While there is a variety of research on different perspectives, there is a very limited body of research that examines how they can be used together to enhance flexibility (Whitney 1986). The definition of flexibility is in itself varied (look at Volberda (1996), Ciborra (1996), Sethi and Sethi (1990) for some characterizations of organizational and supply chain flexibility). Flexibility can be both reactive, as in response to environmental uncertainty, or proactive, as a bank of capabilities maintained by the organization to respond to future needs, or redefine the environment itself (Gerwin 1993). Irrespective of environmental uncertainty, organizations may maintain flexibility capabilities for future needs (Hall and Tompkin 1990) and these flexibility capabilities, while present, irrespective of whether they are used or not, are likely to impact product flows, cost and inventory holdings in the supply chain. In this paper flexibility is defined as an organizational capability that enables it to reactively and proactively modify the range, speed and cost of products and services delivered to the customers or the very processes that produce these products and services. This is akin to Bahrami's (Bahrami 1992) definition of flexibility as the ability to precipitate intentional changes, continuously respond to unanticipated changes, and to adjust to the unexpected consequences of predictable changes (Bahrami 1992). We look at organizational, technological and product based measures of flexibility and study their combined effect on inventory flow integration in the supply chain. The research model is presented in Figure 1.

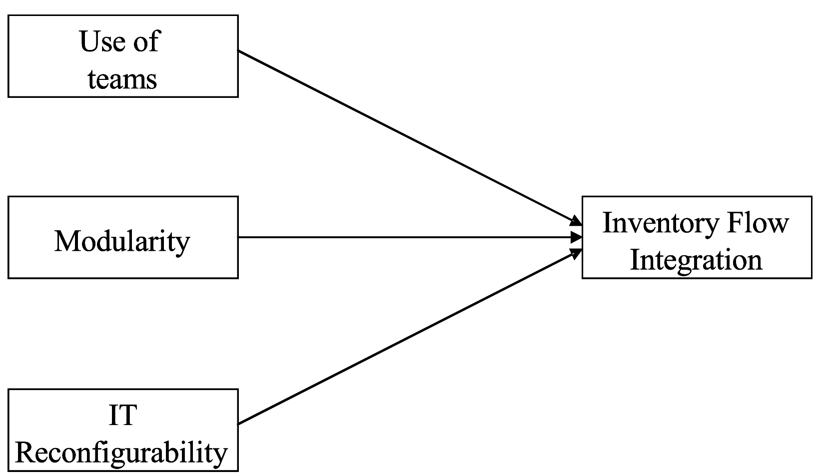


**Figure 1. Research Model**

### *Use of Teams*

Organizations that are flexible blend organic forms of organization with traditional structures (Bahrami 1992). More recently, researchers have held that organic structures do not provide clear reporting relationships, grouping skills and concise assignment of responsibility, authority, and accountability. In fact the ambidextrous model of organization innovation holds that formalized structures are essential for diffusing innovations in organizations (Damanpour 1991). Lack of formalized structures may often lead only selected organizational units using new information technologies and manufacturing technologies required for implementing integrated inventory flows across the supply chain. On the other hand, researchers argue that firms have to be structured and yet chaotic, that they need to strike a balance between stability and flexibility, control and autonomy to operate in today's changing environment (Bahrami 1992). Organizations achieve this balance between flexibility and structure by the use of multifunction teams for routine as well as non-routine tasks (Volberda 1996). Team based overlays are used on current organization structures to enhance flexibility while retaining formality. The use of teams is the most common organization flexibility capability cited across various studies (Bahrami 1992; Ciborra 1996; Volberda 1996). Use of teams enables organizations to rapidly account for changing signals in the marketplace, modify their response strategies and plan new and creative ways of developing new products and delivery mechanisms across the supply chain. In addition many supply chain integration approaches such as supplier partnerships, joint management of inventory and just in time deliveries are associated with the use of teams in organizations (Brunelli 1999; Legare 2001).

*Hypothesis H1: Use of teams is positively associated with inventory flow integration*

### *Modularity*

Modularity is the reduction in the number of parts and suppliers and hence the complexity of the supply chain (Mabert and Venkatraman 1998). Modularity can enable organizational flexibility in a variety of ways. The objective of modular product design is to be able to offer increasing product differentiation, without increasing product complexity (Van Hoek and Weken 1998) by using standardized interchangeable components (Lampel and Mintzberg 1996). Modular product designs are associated with common product platforms that can be used by a variety of products (Anderson and Narus 1995). They can also enable a reduction in lead times because products can be manufactured simultaneously (Feitzinger and Lee 1997). Modular production is likely to be associated with loosely coupled team-based organizational subsystems that coordinate with each other through the information embedded in modular product designs (Sanchez and Mahoney 1996). Modular structures also enable organizations to rapidly integrate resources and capabilities of partner organizations (Strader et al. 1998). Modularity enables the coordinated creation of knowledge across the supply chain (Rai 2001). When organizations need to make a modification in either the product mix or product design (Gerwin 1993), modular product design can ease product innovation or product mix modification. Industries with innovative products that have short life cycles are early adopters of modular production (Starr 1965).

Product modularity has been identified as an important product characteristic that is likely to influence supply chain management (Baldwin and Clark 1997). The manufacturer increases the breadth of its control over the supply chain while reducing the number and scope of activities it performs (Ealey and Troyanobermudez 1996). Modular products reduce transportation and inventory costs by reducing the variety of products transported or held in inventory. Variety is again introduced in the distribution channel when assembly takes place as close to the point and time of delivery as possible. Modular production enables inventory flow integration by drawing suppliers further and further into the manufacturing process. It is also likely to increase the control of the manufacturer on downstream delivery and assembly. This leads us to the following hypothesis:

*Hypothesis H2: Modularity is positively associated with inventory flow integration*

### *IT Reconfigurability*

An integrated IT infrastructure is considered essential for supply chain integration (Sanchez et al. 2001). It enables the seamless flow of information within and across organizational boundaries. It implies that the organization has already established physical and logical channels, such as connected applications and common data definitions for the smooth flow of information. However, tightly integrated infrastructures can be vendor specific, because there are problems in integrating different vendors' systems. Changes in technology standards and competitive structure in the computer vendor industry can seriously affect the viability of such infrastructures over time. Even though such infrastructures may facilitate the development of new supply chain processes at a given point in time, their ability to enable the redesign of supply chains is suspect. Integrated IT infrastructures can limit the organization's choice of new technologies from different vendors that may be required for implementing new processes. IT infrastructure is reconfigurable if components of the existing infrastructure can be recombined, or new systems from different vendors can be integrated into the existing infrastructure in response to changing requirements. An IT infrastructure also needs to be reconfigurable if it is to enable the redesign of the supply chain. A reconfigurable IT infrastructure does not constrain the organization in redesigning its inventory flow processes, and changing its inventory holding and product assembly patterns and its manner of collaborative inventory management with existing and new suppliers and partners across the supply chain.

*Hypothesis H3: Reconfigurabiliy is positively associated with inventory flow integration*

## The Empirical Study

### *Instrument Development*

Data were collected using a self-report survey instrument, which was carefully developed using guidelines and exemplars in the IS literature, for example, Straub (1989) and Sethi and King (1991). Survey items associated with each construct are shown in Table 1. We systematically developed and validated measures for this study. Items associated with these constructs used a seven-item Likert type scale where respondents were asked to state their agreement with a given statement on a scale that ranged from “strongly agree” to “strongly disagree” with its midpoint anchored as “neither agree nor disagree.” Given that several measures are being developed for the first time, great care was taken to assess content validity.

### *Data Collection*

A mailing list of supply chain and logistics managers was compiled from the list of attendees of the Annual Conference of Council of Logistics Management (CLM) in the year 2000. Target respondents for the survey were considered to be senior or middle managers with direct responsibility for supply chain management or logistics function in the organization. Approximately 1800 names were randomly selected from the list. All organizations that did not belong to manufacturing or retail industries were removed from our sample. The final list consisted of 432 manufacturing and retail organizations. The survey was first mailed out and then subsequently made available on a web site; the address of the website was sent only to people on the mailing list. After accounting for undelivered and invalid mailing and incorrect e-mail addresses, the effective mail out was 360 surveys. We received a total of 110 combined responses via return mail, web and e-mail. The effective response rate was 30.55%. The median organization size was 4000 employees and the median organization revenue was 1.5 billion dollars. We tested and found no response bias across groups of respondents, using analysis of variance techniques.

### *Measurement Validation*

We chose PLS for data analysis, because of our emphasis on theory development. The first stage of data analysis focused on assessing the measurement properties of sub-constructs. A construct is considered to be unidimensional if all indicators ‘reflect’ the same unmeasured latent construct. We created composite variables from the multiple items used to measure each sub-construct, which served as formative indicators for latent variables specified in the structural model. There is a choice between using factor scores or summated scales for creating composite variables. Factor scores represent a composite index of all items that load on the factor according to their loadings. Since loadings are particular to the sample, comparing factor scores across samples is difficult. Summated scales are based on mean values of the items and offer the advantage of being replicable across samples. It is generally recommended that if transferability is desired then summated scales are more appropriate (Nunnally 1978; Hair et al. 1995). Accordingly, we decided to use a summated scale approach to compute values for the composite variables and all scores were standardized to a 0-1 range for purposes of statistical analysis.

In PLS (Joreskog and Wold 1982), latent constructs can be modeled as either formative or reflective. Reflective indicators are parallel measures that co-vary to the extent that they measure the same underlying construct. Formative indicators are assumed to cause the latent construct. These indicators are not necessarily correlated and may occur independently of one another.

## Results

All the constructs in this study are modeled as reflective. Reflective indicators are those that can be viewed as being affected by the same underlying construct. These indicators are parallel measures that covary to the extent that they measure the same underlying construct. For reflective indicators, a rule of thumb is to accept loadings of .707 or more which implies more shared variance between the construct and its measures, than error variance. This implies that more than 50 percent of the variance in the indicator is shared with the underlying construct. Table 1 presents the results of the measurement model.

The PLS method does not directly provide significance tests and confidence interval estimates of path coefficients in the research model. In order to estimate the significance of path coefficients, a bootstrapping technique was used. Bootstrap analysis was done with 500 sub-samples and path coefficients were re-estimated using each of these samples. The vector of parameter estimates was used to compute parameter means, standard errors, path coefficient significance, indicator loadings, and indicator weights. This approach is consistent with recommended practices for estimating significance of path coefficients and indicator loadings (Löhmoeller 1984) and has been used in prior IS studies (Chin and Gopal 1995; Compeau and Higgins 1995; Huggins and Schmitt 1995; Ravichandran and Rai 2000). Figure 2 provides the results of PLS analysis.

**Table 1. Measurement Properties of the Research Model**

| Items | Weight |
|---|---|
| ***Use of teams*** | |
| Multifunctional teams are regularly used for organizational work. | .821 |
| Organizational units and teams continuously learn about new technologies and markets. | .937 |
| ***Modularity*** | |
| Uniqueness in product parts and designs has been minimized. | .632 |
| Product parts and subassemblies are shared across many products. | .781 |
| Production processes are shared across many products. | .826 |
| Products have a modular design. | .691 |
| ***Reconfigurability*** | |
| The processing capability of our IT infrastructure (transaction processing) can be scaled up or down as needed. | .727 |
| Our IT infrastructure constrains us in redesigning supply chain processes. | .822 |
| Our IT infrastructure prevents us from changing our supply chain partners (e.g. suppliers, customers, logistics partners). | .809 |
| Our IT infrastructure prevents us from changing communication and reporting linkages across departments and the supply chain. | .836 |
| ***Inventory Flow Integration*** | |
| Inventory holdings are minimized across the supply chain. | .788 |
| Supply chain wide inventory is jointly managed with suppliers and logistics partners (e.g. UPS, FedEx). | .750 |
| Suppliers and logistics partners deliver products and materials just in time. | .628 |
| Distribution networks are configured to minimize total supply chain–wide inventory costs. | .694 |

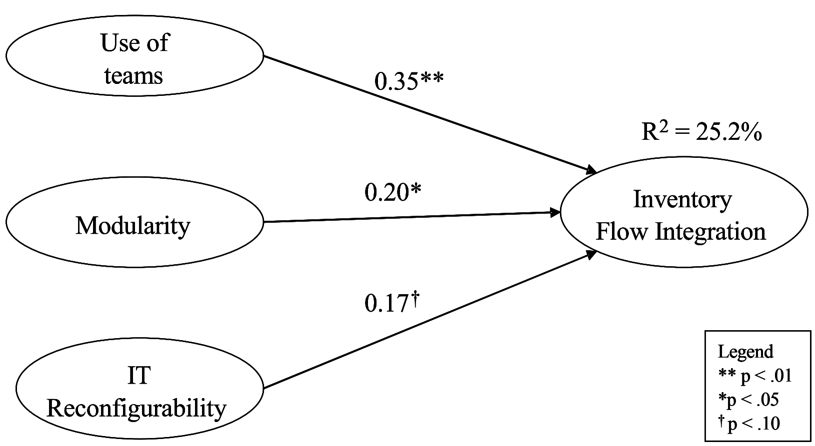


**Figure 2. Results of PLS Analysis**

One indicator of the predictive power of path models is to examine the explained variance or R2 values (Barclay et al. 1995; Chin 1998). R2 values are interpreted in the same manner as those obtained from multiple regression analysis; they indicate the amount of variance in the construct that is explained by the path model (Barclay et al. 1995). The results indicate that the model explained 25.2 % of the variance in inventory flow integration. The significance of the path coefficients provides additional evidence in support of the research model.

Hypothesis H1 and H2 are supported. The path from reconfigurability to inventory flow integration is significant at .10 level. Further two items in inventory flow integration, just in time deliveries and distribution network configuration show loadings below .707. In addition, minimization of uniqueness in product parts and designs does not share 50 percent of the variance with the underlying construct of modularity. The reliability and unidimensionality of these items was calculated in a separate study with Cronbach's alpha and factor analysis. All of the measures used in this study had an alpha greater than .7 (cronbach's alpha was not calculated for the two item measure use of teams). Most of the loadings in this nomological framework are .6 or higher, and this being an exploratory study, we decided to retain these properties as measures of the underlying constructs. The lack of a strong relationship between IT infrastructure reconfigurability and inventory flow integration may suggest that our measure of inventory flow is unable to capture the long term business process capabilities that are enabled by open IT infrastructures, or that IT reconfigurability may impact other intermediate business, organizational or IT capabilities, which in turn enable inventory flow integration.

## Discussion

In hypercompetitive environments, organizations try to balance the imperatives of flexibility and efficiency simultaneously (Adler et al. 1997). Organizational mechanisms that enable flexibility such as modularity, interoperable IT infrastructures and use of cross-functional teams enable organizations to be responsive to rapidly volatile supply and demand signals in the digital age, at the same time minimizing costs and inventory holdings across the supply chain. The results of this study indicate that inventory flow integration, while apparently an efficiency imperative, that increases the interdependence of various supply chain linkages and reduces already existing buffers, is enabled by flexibility capabilities in the organization.

Future research needs to investigate this dichotomy between flexibility and efficiency in organizations. Adler, Goldoftas and Levine (1997) examine this tradeoff between flexibility and efficiency by looking at NUMMI, a joint venture between Toyota and GM in US. NUMMI beat the big three automakers in efficiency, quality as well as model changeover flexibility (Womack et al. 1990). Future research can investigate the joint optimization of flexibility and efficiency, by examining whether the simultaneous use of flexibility and efficiency capabilities enables organizations to optimize efficiency as well as growth and innovation based measures of organization performance.

Adler, Goldoftas and Levine (1997) look at a variety of organizational structural dimensions that enhance flexibility and efficiency at the same time. However an organization has a repertoire of many mechanisms to meet its flexibility needs, and at a macro level, these mechanisms of product design, organization structure and information technology interact with each other and jointly influence the organizational response to flexibility needs. Some prior research points to the association between modularity and use of teams (Sanchez and Mahoney 1996), modularity and IT infrastructure flexibility (Duncan 1995) and IT and the use of teams (Rutkowski et al. 2002). Our study suggests that having multiple forms of flexibility, adds up in enabling inventory flow integration in the supply chain. There is a need to further investigate the theoretical interrelationships between organizational, product and technology based measures of flexibility by drawing upon relevant reference theories in organizational flexibility. The impact of organizational flexibility on inventory flow integration may also be modeled along the lines of internal flexibility and external flexibility approaches suggested by Volberda (1996). Managers can identify their flexibility and efficiency approaches in each cell of the following framework (Table 2), and understand the implications of any gaps. Focusing both on efficiency as well as flexibility in the organization is enabled by a choice of various strategies such as teams, job enrichment, switching roles and partitioning (Adler et al. 1997) and the tradeoffs between them. Incorporating both flexibility and efficiency dimensions across the supply chain is akin to partitioning across organizational units. In partitioning different organizational units can perform flexibility and efficiency roles, partitioning raises problems of coordinating flexible and bureaucratic structures together because of differences in language, culture and workstyles (Bowen and Lawler 1992). Future studies need to draw further insights about the tradeoffs between internal and external flexibility dimensions and the coordination problems associated with balancing flexibility and efficiency at different steps in the supply chain. It is suggested that trust has a central role in enabling organizations to balance flexibility and efficiency across the supply chain (Adler, Goldoftas and Levine 1997).

**Table 2. Flexibility and Efficiency**

| | Internal Flexibility | External Flexibility |
|---|---|---|
| Internal Efficiency | Teams and temporary overlays on formalized structures | Formalized structures and Market exchange mechanisms |
| External Efficiency | Supply chain Integration and organic organization structures | Integration of supply chain through information sharing and partnerships |

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