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Coordination Begins at Home: Measuring Coordination Complementarities in Supply Chain Environments

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ABSTRACT

This research-in-progress presents a framework, grounded in Coordination theory (Thompson, 1967), to examine coordination as a complementary investment to the business value of Supply Chain Management (SCM) environments. Given that one of the objectives of a SCM is to reduce transaction costs, including coordination costs, this framework proposes that for supply chains to prosper, the technology must support the appropriate inter- and intra-organizational coordination mechanisms. We propose using scenario analysis to measure the information technology payoff in a firm by measuring the appropriateness of its coordination mechanism.

Keywords

Supply Chain Management, Coordination, Complementary Investments, Business Value

INTRODUCTION

An important contribution of Information Technology (IT) has been to reduce the friction between transactions, thereby reducing transaction costs. Transaction costs are explained by a number of components such as operations risk, opportunism and coordination costs. Coordination costs include cost of exchanging information about demand, product characteristics and availability between partners (Clemons et al., 1993). While coordination *between* partners has generally been the focus of previous and ongoing supply chain research, a first step in successful partner coordination begins *within* each partner organization.

Coordination imposes tangible costs; therefore organizations must match the need for coordination with an appropriate mechanism. Given that IT has the capability to reduce coordination costs, an organization must make complementary investments in creating coordination mechanisms which when appropriately used can result in SCM investment payoff.

COORDINATION AND CONTEXTS

Intra-organizational coordination

The impact of coordination on organizational efficiency and flexibility is felt at many levels. At an intra-organization level, coordination plays an important role in understanding the dynamics between two software programmers working upon a business application, a team attempting to coordinate a marketing campaign project, the design and manufacturing departments involved in the development of a new electronic device, or two units of a multinational automaker coordinating purchase needs for raw materials and demand for a vehicle.

Intra-organizational coordination can be improved if an organization is designed so that information processing capacity matches task uncertainty (Premkumar, 2000). For example, appropriate coordination strategies influence success of systems development activities and reduce project risk (Andres et al., 2002; Crowston, 1997; Nidumolu, 1995; Nidumolu, 1996). On the other hand, lack of IT coordination with other functions can lead to significant costs or business failures. For example, case studies in ERP implementation have exposed the risk from lack of coordination and the dramatic impact it can have on organizations' profitability and competitiveness; e.g. Hershey's inability to deliver $100 million of candy in time for Halloween 1999 (Koch, 2002). In an extreme case Foxmeyer Drugs' insolvency was blamed upon failure of their ERP to coordinate business activities (Scott, 1999). When an organization's operations are not well coordinated, the repercussions due to lack of internal coordination can impose high transaction costs on partners in a supply chain. For instance when the warehouse inventory system is not integrated with manufacturing systems, not only is production planning at a loss to determine which products to make, the supply chain partner is equally at a loss whether to place an order because it cannot determine which products are available for delivery on a certain date. Thus lack of internal coordination can lead to opaqueness of demand, product characteristics and availability.

Inter-organizational coordination

With the increasing use of electronic networking, strategic alliances and supply chain integration have expanded the reach of organizations, lowering coordination costs in the process (Clemons et al., 1993; Malone et al., 1987). Rapid coordination of activities between partners is evident from the experience of Savers, a thrift store, which was about to send 150,000 volumes of books for recycling when Amazon.com coordinated the integration of Savers' inventory system. Instead of shredding the books, Savers now fills 800 online orders each day (Acohido, 2003).

Transaction cost, organizational, and political economy theories of the role of information technology in inter-organizational relationships collectively provide foundation for the information processing theory, whose underlying axiom is that inter-organizational performance is driven by a fit between the information processing needs that arise from sources of uncertainty and the information processing capabilities that are derived from an array of coordination mechanisms, including structural, process, and IT-mediated mechanisms (Bensaou et al., 1996). The level of coordination should match environmental uncertainty, acceptable levels of variation, and cost for non-performance (Premkumar, 2000).

A supply chain is fully coordinated when all decisions are aligned to accomplish global system effectiveness. Channel coordination, operational efficiency and information sharing improve overall supply chain performance (Lee et al., 1997). Coordination mechanisms may include contracts and other exchange agreements (Miles et al., 1992), but in supply chains, coordination is more often achieved through information sharing, logistics coordination and organizational relationship linkage (Lee 2000). While coordination could be achieved with centralized decision making; decentralized decision making with specific coordination mechanisms is more appropriate in most supply chains. Coordination mechanisms may include price and non-price strategies, and performance measurement schemes such as transfer pricing arrangements between sites, performance metrics, and operational constraints (Sahin et al., 2002). Trust can impact the choice of coordination mechanism (Hart et al., 1998). (Simatupang et al., 2002) suggest that there are four coordination modes in a supply chain – logistics synchronization, information sharing, incentive alignment, and collective learning, based on two dimensions of coordination: focus of coordination (operational, organizational), and mutuality of coordination (complementarity, coherency).

While integration provides significant cost saving opportunities and flexibility, it also increases responsibility and associated risk to manage coordination efforts. Failure to integrate and coordinate with partners can, at the very least, increase transaction costs. Lack of coordination occurs when decision makers have incomplete information or incentives that are incompatible with system-wide objectives. Idiosyncratic investments in suppliers are often made to reduce the risk of coordination failure (Bensaou et al., 1999).

More recently, increased outsourcing, particularly offshore outsourcing, has renewed interest in the need to understand coordination costs. Although outsourcing arrangements offer flexibility and lower per unit costs, the coordination costs of miscommunications, operations risk, and partner opportunism must be balanced against the benefits. Web Services, ASPs and Utility Computing offer another perspective where an organization can outsource entire business processes, thus generating renewed interest in coordination costs.

COORDINATION THEORY

In 1967, Thompson, an organization theorist, argued for an organizational design approach beyond governance structures to manage organizational dependencies (Thompson, 1967). He suggested that three types of interdependence - pooled, sequential, and reciprocal should be coordinated by *standardization*, *plan*, and *mutual adjustment* mechanisms, with increasing communication and decision-making requirements. Organizations would most effectively manage costs when appropriate coordination mechanisms were matched with the required type of interdependence.

Malone and Crowston extended Thompson's study to a multidisciplinary theory of coordination, the process of managing dependencies among or between organizational activities (Malone et al., 1990) with application to organization and process design as well as systems design (Albino et al., 2002; Crowston, 1997; Kim, 2000; Malone et al., 1990; Malone et al., 1999). Coordination theory has been applied to specific cases of intra-organizational coordination (Crowston, 1997) and inter-organizational coordination (Balasubramanian et al., 2002; Kumar et al., 1996). The underlying assumption is that a fit between interdependence type and coordination improves alignment and reduces risk.

MEASURING COORDINATION IN THE SUPPLY CHAIN: PROPOSED FRAMEWORK

Companies must utilize appropriate internal as well as external coordination for effective supply chain performance. We suggest that organizations will invest in supply chain coordination mechanisms that incur lowest coordination costs.

Various information technologies support different needs for interdependence. Using coordination theory, we suggest that organizations with coordination mechanisms appropriately matched with required tasks will have higher performance supply chains. Before we introduce our framework, we discuss the measurement of supply chain performance.

There are multiple ways to measure supply chain performance. Based upon a review of the literature, we categorized supply chain metrics into three major categories: efficiency, output/synchronization, and agility (Beamon, 1999; Gunasekaran et al., 2001; Keebler et al., 1999; Landeghem et al., 2001; Neely et al., 195; New, 1996; Sambamurthy et al., 2003; Shah et al., 2002; van Hoek et al., 2001; Vickery et al., 1999; Viswanadham, 2003). While corresponding closely to Beamon's (1999) resources, output, and flexibility, we use broader definitions to suit the IT complementarity theme and summarize the components in Table 1. Efficiency metrics include cost, time, and resource performance or utilization. Synchronization is introduced as an important output metric. Agility is increasingly mentioned as one of the coming challenges in the international business world (van Hoek et al., 2001). Our categorization incorporates more specific dimensions for agility from (Sambamurthy et al., 2003). Agility encompasses different types of supply chain flexibility such as product, volume, launch, and distribution flexibility and responsiveness to target markets (Vickery et al., 1999).

Table 1: Supply Chain Metrics

Efficiency	Output/Synchronization	Agility
Time	Quality	Customer
Cost	Delivery performance	Operational
Resource performance	Synchronization	Partnering

Coordination theory suggests that rational organizations match appropriate coordination mechanisms with the types of interdependence required. We extend this to both intra- and inter-organization supply chain investments and propose (Proposition 1) that appropriately matched coordination investments will support corresponding supply chain metrics.

Proposition 1: Organizations will invest in a coordination mechanism that incurs lowest transaction costs

> Proposition 1a: When the interdependence type is pooled, organizations will utilize IT for Standardization to achieve efficiency in their activities

> Proposition 1b: When the interdependence type is sequential, organizations will utilize IT for putting in place Plans to achieve process synchronization

> Proposition 1c: When the interdependence type is reciprocal, organizations will utilize IT for Mutual Adjustment to become more agile

(Thompson, 2003) indicates that the type of interdependence and coordination mechanism chosen form a Guttman-scale where sequential interdependence assumes that pooled is included; and reciprocal includes both sequential and pooled but generally at higher costs. Thus, performance of IT to support coordination plans will also be more efficient and coordination via mutual adjustment will be more efficient and synchronized as well as agile.

In Table 2, we present examples of both complementary intra- and inter-organizational coordination mechanisms, including IT, as well as some examples of coordination metrics to measure both intra- and inter-organizational performance of the supply chain.

RESEARCH METHODOLOGY – RESEARCH IN PROGRESS

We propose to utilize the scenario analysis approach to investigate (i) what are appropriate coordination mechanisms for each type of interdependence and (ii) the impact of choice of these mechanisms on supply chain performance.

Scenario Analysis is used by Webster and Trevino (Webster et al., 1995) in a media choice study in which they provided decision makers with policy capturing scenarios, followed by survey questions. Scenario analysis is preferred when subjects overestimate the importance of minor factors or are inclined to give a politically correct answer (Zedek, 1977). This method allows assessment of 'theories in use' as opposed to 'espoused theories of action.' (Argyris et al., 1974) For instance, if asked about how they ordered new software, subjects are likely to answer by citing the official ordering process such as filling out a requisition process, whereas in practice they may have utilized a higher cost coordination mechanism such as a meeting with the IS manager. Another characteristic of scenario analysis relates to its richness of

within-subjects results in which they are asked about which of the several mechanisms they picked, thus providing rich data.

Table 2: Coordination mechanisms and complementary IT investments and metrics

Coordination Mechanism	*Intra*-organization Mechanism and IT	Coordination metrics	*Inter*-Organization Mechanism and IT	Coordination metrics
Standardization	Policies, Rules; INTRANET PORTAL	Efficiency: Projected vs. Actual - schedule production, productivity targets	Agreements and Contracts EXTRANET PORTAL	Efficiency: stock-out reduction; error reduction; inventory reduction; cost reduction; cycle time reduction
Plan	Process Steps; INTRANET ONLINE FORMS	Synchronization: Process targets, delays, rejection rates, Process changes, On-time, JIT	Process Standards (Rosetta Net), On-time deliveries, Compliance with quality standards EDI; VMI	Synchronization: forecast/demand accuracy, smoother demand patterns; on-time delivery
Mutual Adjustment	Process Outcomes; ERP	Agility: User and employee satisfaction, Response to market demands, quality of decision-making	Collaboration New product development, product modification, technology upgrades/adjustment CPFR, SCM, eHUB, EXCHANGES	Agility: Responsiveness (customer, operational, partnering), time to market, time to change strategy

Our first step is to conduct field interviews with supply chain managers to understand the level of interdependence and coordination required for various tasks, the coordination processes and the role of technology, and impact on supply chain outcomes. We will map findings from these interviews with the literature to develop scenarios. The scenarios will be brief business situations controlled for interdependence type (pooled, sequential, and reciprocal), survey questions to assess the type of coordination exercised (standardization, plan and mutual adjustment), and appropriate metrics to capture SCM business value (efficiency, synchronization and agility). Two potential scenario examples, one each for intra- and inter-organizational coordination are shown in Table 3.

Table 3: Potential Scenarios

Scenario	Inter-dependence Type	Appropriate coordination mechanism	Coordination fit	Coordination mismatch	Metrics
Intra-organizational: Marketing department revises forecast	Reciprocal	Mutual adjustment	ERP system updated so manufacturing can alter plans appropriately	Sales folks email the new forecast to manufacturing	All including agility
Inter-organizational: Customer changes a purchase order	Pooled	Standardi-zation	Goes directly into supplier's ERP system through extranet portal.	Calls up customer and asks for change to be made.	Efficiency

CONCLUSIONS

We have shown how coordination theory can be used to understand the choice of coordination mechanisms in a supply chain. Since extended supply chain coordination is predicated on internal coordination, we focus on both intra and inter-organization coordination mechanisms. We suggest that complementary investments in appropriate coordination mechanisms can improve supply chain performance. Our research will use scenario analysis in order to understand the coordination choices in organizations and their impact.

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