# INTEGRATED INFORMATION SYSTEMS AND INTERORGANIZATIONAL PERFORMANCE: THE ROLE OF MANAGEMENT ACCOUNTING SYSTEMS DESIGN

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## ABSTRACT

*The interorganizational environment faced by business organizations presents unique challenges for management accounting and control. Past management accounting research has shown interest in such collaborations because despite their benefits, such relationships pose significant issues of coordination and control. As information and communication systems supplement management control systems in their support of decision facilitation and decision influencing, examining the design of management accounting systems (MASs) in the management of interorganizational relationships and assessing how it affects the attainment of interorganizational exchange partner performance objectives is important. In this chapter, I extend past accounting research to examine the complementary nature of decision-facilitation and decision-influencing objectives of MAS design as enabled by the use of integrated*

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*information systems in interorganizational settings. The economic theory of complementarity is employed to examine synergistic effects of complementary MAS objectives. A field survey is used to examine hypothesized relationships, and data were obtained from 116 organizations involved in strategic alliance activity. This chapter reports findings that support the view that the degree of complementarity in decision-facilitation and decision-influencing objectives assists in the development of capabilities that enhance performance in the interorganizational relationship. The study blends theory in the areas of strategy, information systems, and management accounting and extends management accounting research in the context of IT-enabled interorganizational relationships.*

## INTRODUCTION

In the recent past, business organizations have been heavily engaged in interorganizational exchanges, including both business alliances and joint ventures (Chalos & O'Connor, 2004; Das & Teng, 2000; Ireland, Hitt, & Vaidyanath, 2002). Despite this growth, an increased number of alliances fail or break up prematurely. Past research has posited various reasons for alliance failure, such as lack of partner cooperation (Harrigan, 1988; Zaheer & Venkatraman, 1995) and misfits in the adopted governance structure of these alliances (Gulati, 1995; Parkhe, 1993; Young-Ybarra & Wiersema, 1999; Zaheer & Venkatraman, 1995).

This chapter examines the effectiveness of the design of management accounting systems (MASs) that are used to govern interorganizational exchanges. Relationships at the interorganizational level present unique challenges for management accounting and control because of the potentially conflicting objectives of information that is being shared in such exchanges. For example, past management accounting research has examined aspects of control system design that are based on assumptions of opportunistic behavior between partners within the context of bounded rationality (Anthony & Govindarajan, 2004; Otley & Berry, 1980; Simons, 1995, 2000). This line of research emphasized agency costs associated with the separation of ownership and control (Baiman, 1982). Past literature has examined the decision-influencing uses of management accounting information to reduce tensions associated with increased monitoring of agent actions and willingness to share private information (for a review, see Sprinkle, 2003;

Sprinkle & Williasmon, 2007). In addition, while the decision-facilitating objective of management accounting information can be useful in revising beliefs about important dimensions of trading partner behavior (Baiman, 1982), research has only recently examined the joint impact of decision-influencing and decision-facilitation information use (Abernethy & Vangoni, 2004; Drake, Haka, & Ravenscroft, 1999; Grafton, Lillis, & Widener, 2010; Indjejikian & Matejka, 2006), while their interactions have not been examined in the interorganizational context.

In the modern business environment, interorganizational exchanges are supported by the implementation and use of integrated information systems. Integrated information systems are characterized by common data standards and business processes across partners and facilitate information flows and activity coordination (Barua, Konana, Whinston, & Yin, 2004; Johnston & Vitale (1988). Integrated information systems may also enable the development of organizational capabilities to support strategic goals in an interorganizational exchange (Sambamurthy, Bharadwaj, & Grover, 2003). As organizational capabilities are created by the effective design and development of management processes (Garvin, 1998; Grant, 1996), the design of a MAS could help an organization generate such capabilities. A MAS is conceptualized as the information and communication system (Davila & Foster, 2005) that supports the managerial processes of planning and control (Garvin, 1998). A MAS forms a subset of an organization's structural elements that make up its overall management control system (Simons, 1995, p. 5) and can serve both decision-influencing as well as decision-facilitating objectives (Baiman & Demski, 1980) in interorganizational information exchanges.

On the basis of economic complementarity theory, I predict that the decision-influencing and decision-facilitating objectives of MAS design represent complementary design choices made by management that are jointly affected by the availability of integrated information systems in interorganizational relationships. The economic theory of complementarity emphasizes the potential importance of interactions between different elements of organizational design (Athey & Stern, 1998) and provides a basis for understanding how various elements of organizational strategy and management process relate to one another (Milgrom & Roberts, 1990, 1995). On the basis of the complementarity logic, whereby firms are discovering greater avenues for competitive actions through their information value chains and through the functionalities of integrated information systems, there should be synergistic effects in the attainment of complementary interorganizational MAS objectives. These synergies represent

capability-building processes that enable the effective design of managerial processes and help attain desired goals (Grant, 1996; Teece, Pisano, & Shuen, 1997). The complementarity theory's tenets are thus important in explaining why firms develop synergies that enable the attainment of MAS objectives in an interorganizational environment and ensure the success of the interorganizational relationship.

This study therefore examines the synergistic effects of complementary decision-influencing and decision-facilitating objectives on the design of MAS and on the attainment of performance in interorganizational relationships. The study utilizes a field survey to examine these research questions. The use of a field survey allows for a richer, interactive history of responses that might be useful when examining relationships in an interorganizational exchange context (Coletti, Sedatole, & Towry, 2005; Kramer, 1999). The study offers the following contributions. First, it examines the interrelations between decision-facilitating and decision-influencing objectives of MAS design that constitute primary objectives of a MAS in an interorganizational context. Second, the study examines the effect of integrated information systems, which is a synergistic factor that affects the interrelations of MAS objectives and enables firms to enhance performance by making complementary choices in the design of the MAS. Third, the study introduces the strategic capabilities perspective in examining the effectiveness of MAS design and its performance effects in an interorganizational context. This study is one response to the "need for research on the extended enterprise that is linked to traditional management accounting research but which challenges these traditional boundaries using literatures that have begun to explore the contours of the new organizational landscape" (Anderson & Sedatole, 2003, pp. 38–39).

## THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

In interorganizational alliances, integrated information systems are used to exchange information needed for the management of these relationships. The literature on integrated information systems in interorganizational exchanges has devoted considerable attention to the outcomes or benefits of such system use. Wang and Seidmann (1995) and Riggins, Kriebel, and Mukhopadhyay (1994) show that exchange benefits include efficient information sharing, improved coordination, minimized risk, and reduced

transaction costs. Similarly, Garicano and Kaplan (2001) suggest business-to-business (B2B) relationship success depends on the ability of technology to reduce transaction costs, including both coordination costs and motivation costs. B2B exchanges reduce coordination costs by providing high information quality that enables partners to transact efficiently. Lower coordination costs make markets more attractive than hierarchies (Malone, 1987; Malone, Yates, & Benjamin, 1987) and enable changes in the location of decision-making (Gurbaxani & Whang, 1991). Garicano and Kaplan (2001) find that B2B exchanges also reduce motivation costs, such as when imperfect commitment (Milgrom & Roberts, 1992) leads suppliers not to fulfill orders as promised, while other benefits include reduced errors, reduced inventory costs, and higher quality (Bakos & Brynjolfsson, 1993; Malone et al., 1987). Furthermore, information systems integration in interorganizational relationships enables firms to develop strategic capabilities that contribute to business performance (Saraf, Langdon, & Gosain, 2007).

In early research, the concept of strategy was used to denote actions or patterns of actions intended for the achievement of goals (Swamidass & Newell, 1987). Realized strategies, as defined by Mintzberg (1978), emerge through events and environmental interactions as they unfold over time (Dent, 1990). Distinctive competencies in specific strategies may be found within functional areas (Dent, 1990). Integrated information systems cannot by themselves create sustained performance gains for a firm (Chapman & Kihn, 2009). As a result, there is a clear distinction in the literature between the availability of integrated information systems (or IT resources) and the creation of IT-enabled managerial processes that lead to the development of performance-inducing organizational capabilities (Barua et al., 2004; Sambamurthy et al., 2003). Different organizations, therefore, may develop specific strategies that will allow the formation of distinctive competencies over time and lead to competitive advantage and superior performance.

The effect of specific strategies on the design of management accounting and control systems has also been proposed in past accounting research as a critical issue that has not received adequate research attention (Abernethy & Lillis, 1995; Langfield-Smith, 1997), notwithstanding the fact that interorganizational relationships may modify the types of organizational capabilities that are necessary for success. In interorganizational relationships, firms may develop organizational capabilities through the blending of information technology in organizational processes (Barua & Mukhopadhyay, 2000). The strategic management literature extends the resource-based view of the firm (Barney, 1991) to define higher-order organizational capabilities as the source of a firm's performance (Grant, 1996; Teece

et al., 1997). According to this perspective, a firm must develop dynamic capabilities to acquire, integrate, and use resources that are embedded in their social, structural, and cultural context (Eishnhardt & Martin, 2000). Recent IS research has developed theoretical models of such higher-order capabilities resulting from digital options (Sambamurthy et al., 2003) and empirically examined the IT-enabled processes that embed the availability of integrated information systems into organizational processes (Bharadwaj, 2000) and supply chain processes (Rai, Patnayakuni, & Seth, 2006).

The processes of interorganizational coordination and control are important managerial processes (Garvin, 1998) that dictate an organization's success in the alliance relationship. The development of performance-inducing organizational capabilities therefore is dependent on the IT-enabled processes of interorganizational MASs. This implies that research should examine the availability of highly integrated information systems as they enable these strategic processes and enhance the complementarity of specific interorganizational direction-setting and monitoring activities. In sum, the strategic literature in management accounting, information systems, and organizations suggests that integrated information systems are important to interorganizational performance, and they enable the design of MASs for the management of interorganizational relationships.

### *Integrated Information Systems, Complementarity in Interorganizational MAS Objectives, and Interorganizational Performance*

In interorganizational alliances, the extent of use of integrated information systems helps construct the types of information exchange that occur in the relationship. The information exchange relationships related to a MAS could thus be formalized through the use of integrated information systems, to serve the two broad objectives of facilitating decision-making and decision-influencing actions to mitigate control problems (Indjejikian & Matejka, 2006).

The decision-influencing and decision-facilitating roles of management accounting information are not necessarily conflicting or disjoint (Sprinkle, 2003). Information that is provided by integrated information systems can be useful for both decision-influencing and decision-facilitating purposes. Consider, for example, a manager who makes a production capacity decision and is uncertain about sourcing availability of raw materials required for production. In this scenario, information about a critical alliance partner's sourcing capability has decision-facilitation or planning use as well as

decision-influencing or monitoring use. First, information about the alliance partner's sourcing capability may be made available by the integrated information systems, which enables the two partners to collaborate electronically and allows the manager to more accurately plan production capacity and reduce ex ante (pre-decision) uncertainty. Managers also need information to update their beliefs about the consequences of their own decisions and those made by trading partners; thus, interactive control systems facilitate learning (Simons, 1995). The manager could therefore use integrated information systems to obtain information about the alliance partner's future sourcing capability to revise plans about future production capacity and manufacturing budget. At the same time, ex post monitoring information about the alliance partner's past sourcing performance is also useful for future planning purposes. The likelihood of the manager using future decision-facilitating information supplied by the integrated information systems is thus affected by the manner in which the information is used for decision-influencing purposes. As a result, the two purposes are interdependent and both are affected by the extent of integration enabled by interorganizational information technology.

Recent findings in management accounting research support the complementary nature of decision-facilitating and decision-influencing objectives of MAS (e.g., Abernethy & Vangoni, 2004; Indjejikian & Matejka, 2006). In Indjejikian and Matejka, a MAS that emphasizes local decision support was found to exacerbate control problems at the corporate inter-unit level, whereas the use of management accounting practices that emphasize corporate control was found to undermine the effectiveness of local decision-making to the detriment of the firm as a whole. As a result, both decision-facilitating and decision-influencing objectives would need to be supported by MAS design. In a similar fashion, Abernethy and Vangoni (2004) report findings that the two roles of decision management and decision control are in fact complementary and not conflicting in the context of their study. In earlier studies, Drake et al. (1999) report experimental evidence where the benefit of providing detailed activity-based costing information is linked to the firm's incentive compensation system, thus supporting the complementary nature of the decision-facilitating and the decision-influencing objectives of MAS design, in that the use of information for control/monitoring enhances the use of information for planning/decision-making purposes. Tuttle and Burton (1999) also find that the presence of a modest financial incentive increased information cue usage, thus mitigating information overload and increasing task performance, suggesting a close interrelationship between the decision-facilitating and the decision-influencing objectives of MAS information.

As the preceding evidence suggests, recognizing the interrelationships between the decision-facilitating and the decision-influencing objectives of a MAS is important, especially as such interrelationships could have an impact on the realization of performance outcomes in an interorganizational alliance context.

In this study, I employ the theoretical tenets of the economic theory of complementarity (Milgrom & Roberts, 1990, 1992, 1995), which asserts that two factors are complementary when the changes in the level of one factor affects the marginal returns due to the other factor. The design of MAS to meet decision-facilitation and decision-influencing objectives is the result of adoption of economic rational firms of a coherent business strategy that exploits complementarity (Milgrom & Roberts, 1990) in the face of organizational capabilities that are enabled by the use of integrated information systems.

The adoption and use of an integrated information system in an interorganizational alliance is not a marginal decision but rather involves substantial and closely coordinated changes in organizational processes and a whole set of activities (Nicolaou, 2004a, 2004b; Nicolaou & Bhattacharya, 2006; Ross & Vitale, 2000; Scott & Vessey, 2000; Soh, Kien, & Tay-Yap, 2000; Stephanou, 2000). Prior studies examining the successful deployment of IT resources have emphasized the concomitant organizational changes associated with IT adoption (Brynjolfsson & Hitt, 2000; Brynjolfsson, Hitt, & Yang, 2002), which seem to be necessary for integrated information systems to have an effect on a firm's operational performance (Nicolaou, 2004b; Nicolaou & Bhattacharya, 2006). The use of integrated information systems could thus enable synergistic organizational processes, which could have a positive influence on firm performance (Kumar & Van Hillegersberg, 2000). The presence of IT-enabled processes will result in organizational capabilities and enhanced performance when organizations make a series of linked strategic decisions so as to blend IT resources due to the use of integrated information systems with organizational processes and knowledge resources (Barua et al., 2004). If an organization, however, deploys IT resources that are not consistent with complementarity requirements in MAS design, it is not likely to realize returns to scale (Milgrom & Roberts, 1995) and likely to suffer a reduction in corresponding interorganizational performance. This is a similar effect as that observed in organizations that have not aligned their information technology and strategy (Davenport, 2000). As a result, the following research hypothesis is advanced:

**H1.** A high degree of complementarity between the decision-facilitating and the decision-influencing objectives of interorganizational MAS design will have a positive influence on a firm's interorganizational performance.

## RESEARCH METHOD

To examine the study's research question, a combined archival and field survey methodology was employed on a target sample of US public companies. The mail survey provided data from the chief financial officers (CFOs) of organizations involved in interorganizational alliance activity. The archival method primarily assisted in the identification of organizations involved in strategic alliances to enhance the internal validity of the selected sample.

### *Sample and Respondent Selection*

The sample for the study was extracted through a search of public companies that report alliance or joint venture activity in the *Mergent* database. This work has resulted in the identification of 1,896 separate alliances that were created by 893 different US public companies with third partners between the years 1982 and 2005. Of those alliances, 38% involved an international partner, while 70% were initiated in the 1990s, 8% occurred before that time, and the other 22% occurred between the years 2000 and 2005. The industry membership of alliance adopter companies included 47% in manufacturing (standard industrial classification – SIC code 2 or 3), 13% in hotels and other lodging places (SIC code 7), 10% in depository institutions (SIC code 6), and 9% in transportation (SIC code 4), among other industries with smaller participation. The CFO for each of those companies was selected as the appropriate target respondent for the study, as a CFO should have an understanding of the potential effects of the use of IT on the effective operation and control of an alliance.

### *Data Collection*

The research instrument asks the potential respondent to choose one alliance their firm has had or currently has with another business entity. Such an alliance could be the result of a strategic agreement between two firms, and it might have involved the creation of a third entity (as in a joint venture) or not. The respondents have been instructed to focus on the relationship with this interorganizational alliance partner when responding to the various items included in the research instrument. Following Dillman's (1978) recommendation for conducting effective surveys, several steps were taken

during the entire data collection process. First, a preliminary draft of the research instrument was evaluated by expert panels, including faculty members and two individuals (CFOs) from the target population. The instrument was revised as a result of pretesting, ensuring the face validity of the constructs and items. Second, a preliminary letter explaining the study objectives was sent to each selected organization before mailing the first wave of surveys. Third, the first wave was mailed with a business-reply envelope and a letter requesting participation. The instrument was also coded on the author's web space, and potential respondents were given the choice of completing the paper or web-based version of it. Fourth, a postcard reminder was sent about a week after the initial mailing. Fifth, a second reminder packet (including a copy of the original questionnaire and web access instructions) was mailed to nonrespondents within eight weeks of the original mailing. Finally, an e-mail request was sent to nonrespondents with a direct link to the questionnaire web address. The response rate from all attempts is 17.13%, as a total number of 116 responses were received over an effective sample of 677 target respondent firms. Table 1 analyzes the response rate attained in the study.

Tests for nonresponse bias were performed to determine (a) whether the distribution of the effective sample of 677 organizations in the response or nonresponse categories was independent of available demographic characteristics (industrial classification, gross revenue, and number of employees) and (b) whether early and late respondents provided significantly different responses. Chi-square tests indicated no significant differences in the three demographic characteristics. The Hotelling's $T^2$ statistic also indicated no significant differences in the multivariate means of early versus late respondents.

***Table 1.*** Effective Response Rate.

| | | |
|---|---|---|
| Original sample from Mergent database | | 893 |
| Less | | |
| Undelivered questionnaires with no forwarding information | 67 | |
| Declined response due to time pressures | 49 | |
| Declined response due to nonparticipation in surveys | 65 | |
| Declined response for unspecified reasons | 35 | (216) |
| Effective sample size | | 677 |
| Number of completed questionnaires received | | 116 |
| Effective response rate | | 17.13% |

### *Measurement of Model Constructs and Control Variables*

Distinguishing between the characteristics of integrated information systems and the objectives of MAS that are enabled by the availability of integrated systems is important for construct measurement. Firms that are involved in interorganizational alliances may be able to implement decision-influencing and decision-facilitating objectives through the adoption of integrated systems that support collaborative activities. The proper management of appropriate factors that contribute to the attainment of decision-influencing and decision-facilitating objectives relates to the complementary aspects of MAS design, whereas the mere adoption of integrated information systems and the availability of related technological capabilities relate to integrated information systems characteristics. The items used to measure all constructs are given in Table 2.

Table 2 summarizes the five items used to measure integrated information systems characteristics. The items are intended to measure the availability of characteristics such as web-based extranets for data sharing, web-based access over a partner's database, use of IT as a platform to build an organization's information infrastructure, use of web-based add-on modules, and collaborative capabilities.

As defined in the past literature (Zimmerman, 2006), decision-facilitating objectives are based on the set of those activities that take place in an interorganizational collaborative environment to initiate and implement business plans; decision-influencing objectives relate to those activities that take place in an interorganizational environment to ratify the adoption of business plans and monitor implementation. As a result, the constructs of decision-influencing and decision-facilitating objectives are each measured using new items (given in Table 2), which capture the extent to which integrated IT facilitates or enables the attainment of such objectives in an interorganizational environment. As no prior validated items exist for the measurement of these constructs, the items given in Table 2 have been originally developed in this study.

Two control measures were also used to eliminate influences on each of the *decision-influencing* and *decision-facilitating* objectives due to varied motivations to initiate an alliance. Interorganizational alliances may be formed in response to the need for either asymmetry or reciprocity of organizational objectives with those of the alliance partner (Oliver, 1990), and these may influence the types of objectives sought in a firm's MAS. The asymmetry contingency emerges from a desire for control over the other partner due to resource dependence or resource scarcity constraints (Pfeffer &

***Table 2.*** Measurement Items of Model Constructs.

**Integrated Information Technology/Systems: IIS (7-point scale, strongly agree to strongly disagree)**

1. The use of IT enables use of web-based extranets or other data sharing methods with my exchange partner.
2. My alliance partner allows me to have electronic web-based access over relevant portions of their internal database.
3. IT systems served as an essential platform to help build my firm's information infrastructure, including web enablement capabilities.
4. My firm's use of IT systems enables use of web-based add-on modules, including supply chain and customer relationship management.
5. My firm utilizes web-based collaborative capabilities enabled by its IT systems.

**Complementary Objectives of MAS Design (7-point scale, strongly agree to strongly disagree)**

*Decision-influencing objective: DI*

Information provided by my firm's IT systems enables

1. Adequate control over outcomes or results of actions taken by my exchange partner in the alliance.
2. The assessment of alliance (exchange partner) performance over a number of operating metrics, including delivery on schedule, sharing of production plans, and minimization of production delays.
3. Use of web-based monitoring routines that provide information about partner performance over a number of specific metrics.
4. My firm to better monitor exchange partner performance.

*Decision-facilitating objective: DF*

1. The use of IT systems in general has allowed my firm to better coordinate decisions with the exchange partner in this alliance.
2. My firm's IT systems provide adequate information for me to make decisions that affect the relationship with my exchange partner in this alliance.
3. My firm's IT systems provide adequate information for me to plan in advance the potential outcomes of decisions that impact my relationship with this exchange partner.
4. The use of IT systems collaborative capabilities has allowed my firm to better coordinate decisions with the exchange partner in this alliance.
5. The use of IT systems increases transparency of my alliance partner's cost structure.

**Interorganizational Performance: IOPRF (7-point; strongly disagree to strongly agree)**

Please rate the performance of the strategic alliance

*Financial dimension*

a. has been very profitable
b. has generated a high volume of sales
c. has achieved a high earnings growth

*Strategic dimension*

d. has improved my firm's strategic competitiveness
e. has strengthened my firm's strategic position
f. has significantly increased my firm's market share

***Table 2.*** (*Continued*)

*Overall*
g. has been very satisfactory
h. has fully met my firm's expectations
i. all in all, we expect that the strategic alliance with this exchange partner will continue in the long run

*Exchange Partner Performance*
1. Please rate your exchange partner's performance in following the terms of your agreement (*measured as 1 = very poor; 4 = fair; 7 = excellent*).

**Prior Performance: PRIORPRF** (Objective Measures)
a. Please estimate your firm's revenue growth: (a) since the inception of the alliance; (b) during the alliance, if already dissolved **(PRF)**.
b. Please estimate total industry growth: (a) since the inception of the alliance; (b) during the alliance, if already dissolved **(PRI)**.

**Alliance Adoption Contingencies (strongly disagree to strongly agree, 1–7 rating scale)**
*Asymmetry Contingency (ASYMM)*
The primary motivation for my firm to enter into this strategic alliance is to
a. Gain power over the exchange partner through control of resources and information supply.
b. Exert dominant influence over the exchange partner.

*Reciprocity Contingency (RECIP)*
c. Exchange equally important information and share plans useful to both my firm and the exchange partner.
d. Coordinate business plans for mutual benefit.

Salancik, 1978). Such constraints encompass a need for power and control over external resources that may be critical to an organization's operational processing capabilities and could thus represent an exogenous influence on the *decision-influencing* objectives of MAS design. The reciprocity contingency assumes that two organizations that enter into an alliance do so because they anticipate reciprocal benefits, which far exceed costs related to loss of decision-making latitude and costs of managing the exchange. Interorganizational exchange theory (e.g., Levine & White, 1961) emphasizes cooperation, collaboration, and coordination of activities to achieve reciprocal benefits. As a result, it could represent an exogenous influence on the *decision-facilitating* objectives of MAS design. The asymmetry and reciprocity contingencies are each measured using two items (presented in Table 2) that were developed in this research based on the theoretical tenets each assumes.

Interorganizational performance is measured using a number of items capturing perceptions of alliance performance. Alliance performance was measured from the perspective of the focal firm using a set of items that capture the strategic benefits of the alliance. Similar measures of performance have been used in past interorganizational studies. Past research has suggested that alliance performance can be assessed by the extent to which the relationship is productive or worthwhile (Heide & Miner, 1992; Van de Ven & Walker, 1984). Others captured performance by measuring the extent to which the alliance contributes to profits, market share, or competitive advantage (Parkhe, 1993; Simonin, 1997), whereas Young-Ybarra and Wiersema (1999) measured alliance performance an overall expectation. As a result, six items were developed in this study to capture the financial and strategic dimensions of interorganizational alliance performance; in addition, three items are used to assess the perception of overall alliance performance.

In addition, one overall item of exchange partner performance is developed in this study to supplement the alliance performance measures. Exchange partner performance has been defined in past research as the extent to which the supplier has fulfilled the buyer's requirements in terms of price, timeliness of delivery, input quality, and supplier flexibility (Zaheer, McEvily, & Perrone, 1998). This study adapts this definition to develop the one item measuring exchange partner performance.

Furthermore, to control for a potential "halo" effect on performance that could confound the main hypothesized relationships (e.g., Brown & Perry, 1994), I include a measure of prior performance in the model. To the extent that the MAS objectives would maintain their effects on interorganizational performance even after controlling for prior performance, the reliability of the overall model would be enhanced. As mentioned in Table 2, I measured prior performance using the respondent's estimate of their firm's and corresponding industry's revenue growth observed during the time of the alliance.

### *Statistical Models*

I examine the research hypothesis using a simultaneous equation model that is best suited to testing complementary relationships (Athey & Stern, 1998). The model includes the determinants of each of the endogenous variables (decision-influencing and decision-facilitating objectives) and their inter-relation. To ensure identification, I also include the exogenous factors of asymmetry contingency (ASYMM) and reciprocity contingency (RECIP) in

each of the two models. H1 predicts that *decision-influencing* (DI) and *decision-facilitating* (DF) objectives of MAS design will be complementary choices, thus interrelated, and are also jointly determined by integrated information systems (IIS). Following past studies that tested similar complementary relations (e.g., Abernethy, Bouwens, & van Lent, 2004), I use the following system of equations to test this hypothesis:

$$\mathrm{DI}_i = \alpha_0 + \alpha_1 \mathrm{DF}_i + \alpha_2 \mathrm{IIS}_i + \alpha_3 \mathrm{ASYMM} + \varepsilon_i^{\mathrm{DI}} \tag{1a}$$

$$\mathrm{DF}_i = \beta_0 + \beta_1 \mathrm{DI}_i + \beta_2 \mathrm{IIS}_i + \beta_3 \mathrm{RECIP} + \varepsilon_i^{\mathrm{DF}} \tag{1b}$$

Ordinary least squares (OLS) estimates could be biased and inconsistent when endogenous variables appear as regressors in other equations in the system (Wooldridge, 2000), which might be a more frequent problem in models with complementary inputs (Athey & Stern, 1998). I use the Durbin–Wu–Hausman test (MacKinnon, 1992; Nakamura & Nakamura, 1981) to determine the presence of simultaneity equation bias that may be caused by potentially correlated error terms. In both models earlier, I find no evidence of simultaneity bias (Model 1a: $F = 0.20$, $p < 0.00$; Model 1b: $F = 2.32$, $p < 0.13$). For a robustness check, I have also estimated the preceding system of equations using two-stage least squares (2SLS) estimation. All results obtained using 2SLS reinforce the results obtained by OLS estimation. As a result, OLS will be used in the analysis as the 2SLS approach may be sensitive to weaknesses in instrumental variables (Nelson & Stratz, 1990).

Research hypothesis H1 predicts that the endogenously determined decision influencing and decision facilitating will each influence interorganizational performance (IOPRF). As a result, the following two equations are also examined using OLS:

$$\mathrm{IOPRF}_i = \gamma_0 + \gamma_1 \mathrm{DI}_i^{\wedge} + \gamma_2 \log(\mathrm{PRF})_i + \gamma_3 \log(\mathrm{PRI})_i + \varepsilon_i^{\mathrm{IOPRF}} \tag{2}$$

$$\mathrm{IOPRF}_i = \delta_0 + \delta_1 \mathrm{DF}_i^{\wedge} + \delta_2 \log(\mathrm{PRF})_i + \delta_3 \log(\mathrm{PRI})_i + \varepsilon_i^{\mathrm{IOPRF}} \tag{3}$$

where,

DI^ and DF^ are predicted values from Eqs. (1a) and (1b), respectively;
PRF represents the control measure of prior performance of firm in the alliance;
PRI represents the control measure of prior performance of corresponding industry in which an alliance operates; and
the logarithm of PRF and PRI is taken to correct for score range.

## DATA ANALYSIS AND RESULTS

The measurement properties of the items have been examined and tested for convergent and discriminant validity (Boudreau, Gefen, & Straub, 2001). Convergent validity means how well each latent construct captures the variance in its measures. Convergent validity can be evaluated by examining the following measures: individual item reliability (standard is 0.5 or above); composite construct reliability and a measure similar to Cronbach's alpha (standard is 0.7 or above); and average variance extracted (AVE), which measures whether the variance captured by a construct is larger than the variance due to measurement error (standard is 0.5 or above) (Fornell & Larcker, 1981). Table 3 notes that all internal consistency reliability (ICR) coefficients met the 0.7 standard, whereas all constructs also met the 0.5 AVE criterion, supporting convergent validity. The Cronbach's alpha is also shown for each construct for comparative purposes and the same conclusions apply.

Discriminant validity means the extent to which measures of constructs are empirically distinct (Davis, 1989). I assessed discriminant validity by comparing the square roots of the AVE of two measured constructs (notes on the Table 3 diagonal) to the correlation between each pair of constructs. This test is satisfied by all construct pairs in the model. A stricter test of discriminant validity requires that the absolute value of the AVE of each construct is higher than its correlation to any other measured construct. As mentioned in Table 3, this stricter test of discriminant validity is met by all constructs in the model.

### *Testing Complementarity in Interorganizational MAS Objectives and Effects on Interorganizational Performance*

The research hypothesis specifies the complementary nature of decision-influencing and decision-facilitating objectives of MAS design and predicts their effect on interorganizational alliance performance. Models 1a and 1b test the complementary nature of the two constructs and whether they are jointly determined by integrated information systems. These models correspond to the "adoption tests" for testing complementarity as specified by Athey and Stern (1998). Table 4 summarizes the OLS estimation results.

The results of Eqs. (1a) and (1b) (Table 4, panel A) provide strong evidence that decision-influencing objectives of MAS design are positively and significantly related to decision-facilitating objectives ($\alpha_1 = 0.64$; $t = 8.00$),

***Table 3.*** Descriptives, Correlations, and Validity Statistics.

| | | Mean | Standard Deviation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | IIS | 4.68 | 1.66 | *0.92*[ξ] | | | | | | |
| 2 | DI | 4.48 | 1.47 | 0.531 | *0.910* | | | | | |
| 3 | DF | 4.60 | 1.36 | 0.491 | 0.731 | *0.862* | | | | |
| 4 | IOPRF | 5.16 | 1.22 | 0.271 | 0.326 | 0.427 | *0.944* | | | |
| 5 | PRIORPRF | 18.09 | 24.57 | 0.226 | 0.288 | 0.178 | 0.330 | *0.926* | | |
| 6 | ASYMM | 3.32 | 1.78 | 0.269 | 0.296 | 0.311 | 0.233 | −0.082 | *0.935* | |
| 7 | RECIP | 5.44 | 1.51 | 0.282 | 0.229 | 0.317 | 0.258 | 0.060 | −0.050 | *0.927* |
| | ICR* | | | 0.943 | 0.907 | 0.896 | 0.971 | 0.923 | 0.933 | 0.924 |
| | Cronbach's alpha | | | 0.716 | 0.706 | 0.701 | 0.709 | 0.730 | 0.856 | 0.837 |
| | AVE[δ] | | | 0.846 | 0.829 | 0.743 | 0.892 | 0.857 | 0.874 | 0.860 |

*Notes*: Correlations greater than|0.20|are significant at $p<0.05$; correlations greater than|0.25|are significant at $p<0.01$. ASYMM**,** asymmetry contingency; DF, decision-facilitating objective of MAS design; DI, decision-influencing objective of MAS design; IIS, integrated information systems; IOPRF, interorganizational performance; PRIORPRF, prior performance; RECIP, reciprocity contingency.

*ICR = Internal Consistency Reliability coefficient.

[δ]AVE = Average Variance Extracted estimate (cf. Fornell & Larcker, 1981).

[ξ]Diagonal elements are the square root of the average variance extracted (AVE) estimate for each construct. Off-diagonal elements are the correlations between the different constructs.

while decision-facilitating objectives are in turn also positively and significantly related to the setting of decision-influencing objectives of MAS design ($\beta_1 = 0.57$; $t = 8.24$). The two objectives are thus interrelated and are jointly determined by integrated information systems (IIS: $\alpha_2 = 0.20$, $t = 3.11$; $\beta_2 = 0.10$, $t = 1.59$), while both models exhibit high explanatory power (model 1: adj. $R^2 = 54.38\%$; model 2: adj. $R^2 = 52.91\%$). Even though the effect of integrated information systems on decision-facilitating objective was very marginally significant ($p = 0.11$), the joint effect of integrated information systems on both decision-influencing and decision-facilitating objectives was not significantly different. A system test of equality in the effects of integrated information systems on decision influencing and decision facilitating in the 2SLS model was not rejected ($F = 1.81$; $p < 0.1796$), thus supporting the joint effects of integrated information systems on both decision-influencing and decision-facilitating objectives of MAS design.

Eqs. (2) and (3) use the predicted values of decision influencing and decision facilitating from Eqs. (1a) and (1b) to test the complementary

***Table 4.*** Tests of Complementary Relations.

Panel A: Ordinary Least Squares Regressions to Test Complementarity between DI and DF Objectives

| Predictor | Coefficient | Std. error | *t*-Statistic | Probability (two-sided) |
|---|---|---|---|---|
| Model 1a: $DI_i = \alpha_0 + \alpha_1 DF_i + \alpha_2 IIS_i + \alpha_3 ASYMM + \varepsilon_i^{DI}$ | | | | (1*a*) |
| Intercept | 0.46 | 0.36 | 1.30 | 0.20 |
| DF | 0.64 | 0.08 | 8.00 | 0.00 |
| IIS | 0.20 | 0.06 | 3.11 | 0.00 |
| ASYMM | 0.04 | 0.06 | 0.81 | 0.42 |
| $F = 46.70$; $p < 0.0001$ ; Adj. $R^2 = 54.38\%$ | | | | |
| Model 1b: $DF_i = \beta_0 + \beta_1 DI_i + \beta_2 IIS_i + \beta_3 RECIP + \varepsilon_i^{DF}$ | | | | (1*b*) |
| Intercept | 0.95 | 0.39 | 2.45 | 0.02 |
| DI | 0.57 | 0.07 | 8.24 | 0.00 |
| IIS | 0.10 | 0.06 | 1.59 | 0.11 |
| RECIP | 0.11 | 0.06 | 1.87 | 0.06 |
| $F = 44.06$; $p < 0.0001$; Adj. $R^2 = 52.91\%$ | | | | |

Panel B: Ordinary Least Squares Regressions to Test Effect of Complementary MAS Objectives on Interorganizational Performance

| Predictor | Coefficient | Std. error | *t*-Statistic | Probability (two-sided) |
|---|---|---|---|---|
| Model 2: $IOPRF_i = \gamma_0 + \gamma_1 DI_i^{\wedge} + \gamma_2 \log(PRF)_i + \gamma_3 \log(PRI)_i + \varepsilon_i^{IOPRF}$ | | | | (2) |
| Intercept | 2.26 | 0.46 | 4.96 | 0.00 |
| DI^ | 0.53 | 0.10 | 5.35 | 0.00 |
| Log(PRF) | 0.49 | 0.31 | 1.60 | 0.11 |
| Log(PRI) | 0.12 | 0.30 | 0.41 | 0.68 |
| $F = 16.08$; $p < 0.0001$ ; Adj. $R^2 = 33.46\%$ | | | | |
| Model 3: $IOPRF_i = \delta_0 + \delta_1 DF_i^{\wedge} + \delta_2 \log(PRF)_i + \delta_3 \log(PRI)_i + \varepsilon_i^{IOPRF}$ | | | | (3) |
| Intercept | 2.86 | 0.51 | 5.64 | 0.00 |
| DF^ | 0.38 | 0.12 | 3.26 | 0.00 |
| Log(PRF) | 0.61 | 0.33 | 1.84 | 0.07 |
| Log(PRI) | 0.01 | 0.33 | 0.02 | 0.99 |
| $F = 9.08$; $p < 0.0001$; Adj. $R^2 = 21.21\%$ | | | | |

*Notes*: ASYMM**,** asymmetry contingency; DF, decision-facilitating objective of MAS design; *DF*^, predicted value of DF from Eq. (1b); DI, decision-influencing objective of MAS design; *DI*^, predicted value of DI from Eq. (1a); IIS, integrated information systems; IOPRF, interorganizational performance; PRF, control measure of prior performance of firm in the alliance; PRI, control measure of prior performance of corresponding industry in which alliance operates; PRIORPRF, prior performance; RECIP, reciprocity contingency.

effects of MAS design on interorganizational performance. A common method of testing for complementarities is the productivity approach, which involves measuring the effect that decision-influencing and decision-facilitating objectives will have on performance and examining whether interactive terms will have larger effects than the main effects alone (Athey & Stern, 1998). A model where the main and interactive effects of both decision influencing and decision facilitating are present, however, may suffer from a selection bias problem (Athey & Stern, 1998). This selection bias would occur if firms that adopt integrated information systems expect greater returns if they focus on both objectives simultaneously than when they only emphasize decision-influencing and decision-facilitating objectives alone. If these objectives are indeed complements, then the error term would be correlated to the regressors. To avoid this problem, I use the predicted levels of decision-influencing and decision-facilitating objectives from Eqs. (1a) and (1b), and test their individual significance on interorganizational performance. The predicted values incorporate the hypothesized complementarities between the two objectives, given the level of enablement facilitated by the use of integrated information systems. Models (2) and (3) in panel B of Table 4 therefore provide a test for observed complementarities in the two objectives of MAS design, after controlling for the exogenous factor of prior performance. Both models provide significant results with regard to the complementary impact of the decision-influencing and the decision-facilitating objectives on interorganizational performance (Eq. (2): $\gamma_1 = 0.53$; $t = 5.35$; Eq. (3): $\delta_1 = 0.38$; $t = 3.26$), while the explanatory power of both models is at a satisfactory level (model 2: adj. $R^2 = 33.46\%$; model 3: adj. $R^2 = 21.21\%$). These results provide support for research hypothesis H1.

## DISCUSSION AND IMPLICATIONS

This study argues that an organization's adoption and use of integrated information systems in interorganizational alliances enables complementary strategies in the monitoring and facilitation of the interorganizational relationship. This may imply that to the extent a firm follows such complementary objectives and executes effective MAS design choices, it may develop organizational capabilities for the strategic management of the interorganizational relationship and enhance interorganizational performance. In an environment where integrated information systems facilitate the design of MAS and the setting of complementary decision-influencing and

decision-facilitating objectives, the effective employment of such complementary objectives should influence performance in inter-firm relationships.

The study's results support its theoretical arguments. The study argues that even though objectives of MAS design are significant factors of interorganizational performance, their performance influence is best explained when their effects are examined in combination. Economic theory argues that complementary effects are observed when strategies are pursued in combination. The complementarity analysis has shown that the two constructs are in fact interdependent and their influence on performance is best analyzed by examining the second-order effects they help generate. The significant pairwise correlation between the decision-influencing and the decision-facilitating objectives ($r = 0.731$), as given in Table 3, indicates that the two constructs are highly correlated as they are pursued simultaneously. The simultaneous equations approach used to test the research hypothesis, nevertheless, resulted in more powerful significant second-order effects (as specified in research models (2) and (3) by the predicted values of the decision-influencing and the decision-facilitating objectives). The interpretation of these second-order effects is not too dissimilar from results obtained in related studies that use second-order factor analytic techniques (e.g., Rai et al., 2006). These findings suggest that the objectives of interorganizational decision influencing and decision facilitation constitute important managerial processes that determine an organization's success in the alliance relationship. The effective design of a MAS to attain both decision-influencing and decision-facilitation objectives thus helps develop organizational capabilities that enhance performance.

Overall, the findings of this study show that the availability of highly integrated information systems enables these strategic processes and enhances the complementarity of specific interorganizational direction-setting and monitoring activities. These results are consistent with theoretical arguments presented in the strategic management (e.g., Teece et al., 1997) and information systems (e.g., Sambamurthy et al., 2003) literatures. They also extend past findings in information systems integration (Bharadwaj, 2000) and supply chain integration (Rai et al., 2006). This study also extends past management accounting research that advocates systemic approaches to examining the effectiveness of MAS design (e.g., Chenhall, 2003; Chenhall & Langfield-Smith, 1998), and its results help extend the boundaries of management accounting research in the interorganizational strategic context.

This study demonstrates that it is the design and organization of information that is the major explanatory variable of governance choices in IT-enabled business relationships. Although inter-firm relationships depend

on IT for the integration of information flows among networked firms, it is the effective use of IT through the design of MAS, which confers success to interorganizational arrangements. This study offers some novel insights in this area, and future research could build on its findings to further examine the role of information systems use, and effective design of management accounting and control systems, in the success of interorganizational relationships.

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