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INFORMATION TECHNOLOGY ARCHITECTURES FOR GLOBAL COMPETITIVE ADVANTAGE

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ABSTRACT

With products and capital traveling greater distances, unchecked by national boundaries or time zones, information technology has become an indispensable tool for the effective and efficient conduct of international business. Paradoxically, spectacular advances in information technology capabilities have been accompanied by an inability to develop systems that satisfied the information requirements of global firms. This disturbing paradox, encompassing interrelated phenomena such as the opportunities for the strategic use of information technology and the competitive challenges of globalization, served as the staging area for this research.

This multinational, multidisciplinary study examined foreign subsidiary strategic roles (an organizational issue from the disciplines of international business and strategic management) and information technology architectures (a technical issue from the information systems field) by empirically identifying patterns of information technology architectures that reflected the strategic and international context considerations of actual firms. Moreover, it is among the first to move beyond anecdotes to embrace empirical testing and validation of the relationship between information technology architectures and foreign subsidiary strategic requirements. The statistically significant results provided support for a proposed matching of information technology capabilities and the requirements of foreign subsidiary strategic roles. Moreover, as anticipated, international environmental factors appeared to act as constraints on this strategic choice.

OVERVIEW OF GLOBAL OPPORTUNITIES AND CHALLENGES

The extant information systems literature has left no doubt that international firms must overcome several well-defined information technology challenges in order to seize the many information technology opportunities for managing interdependencies among globally dispersed activities. For example, McFarlan (1992) identified several problems associated with international information technology that included: the time required for planning and installation of networks, the possible unavailability of local technical support, and geographic burdens placed on information technology specialists. Prior research has been conducted regarding specific information technology challenges such as: transborder data flows (e.g., Samiee 1984, Waples and Norris 1992), and cultural differences (e.g., Kedia and Bhagat 1988, Robey and Rodriquez-Diaz 1989).

Unfortunately, the abundance of published research on the opportunities and problems of exploiting international information technology has been accompanied by a relative dearth of systematic investigation regarding the relationship between international business requirements and information technology capabilities. The established disciplines of strategic management, international business, and information systems have each, separately, contributed much to the research literature stream and to the practice of global management. However, researchers have generally overlooked the potential integration of these domains. Both the international business and the strategic management disciplines have tended to ignore information systems issues and, as Neo (1991) observed, the literature from the information systems field on the role of information technology has implicitly or explicitly focused on competition in a domestic industry.

CONCEPTUAL FRAMEWORK

Krommenacker (1989) asked if efficient international trade was fundamentally driven by information systems. In other words, he questioned whether more, or more timely, information provided a competitive advantage for firms. He concluded that global markets are driven toward more trade interdependence. Thus, to maximize gains from trade, a firm must define investment priorities that utilize information systems to gain sustainable cost or other advantages over global competitors. The following sections provide brief, but comprehensive, discussions of relevant ideas from the overlap of three fields of study that were brought together to form the underlying conceptual foundation to examine the issues associated with managing information technology for global competitive advantage.

Environmental Constraints

Researchers approaching information technology constraints from an international perspective (e.g., Deans 1991, Steinbart and Nath 1992) have established empirically that global information technology problems are technical, political and social in nature. Documented technical constraints included issues such as: poor quality of foreign telephone networks, hardware incompatibility, variable data transfer speeds, international protocol variations, lack of vendor support in foreign countries, and data definition irregularities between parent and subsidiary units. Politically imposed constraints included: required use of local telecommunications networks, restrictions on the purchase of computer hardware, and currency and exchange rate volatility. Finally, social issues as potential constraints included language differences, recruiting and training problems, and differing concerns about privacy.

Value Chain Linkages

The global competition literature (e.g., Kout et al. 1982, Porter 1989, Bartlett and Ghoshal 1989) noted unequivocally that configuring downstream value activities to exploit factor cost differentials and coordinating upstream value activities to limit intrinsic transaction disadvantages forced international firms to reevaluate the links in their global value chains. Accomplishment of these tasks required further evolution toward internalizing and integrating operations--changes that, in turn, demanded higher levels of information technology-enabled coordination.

Foreign Subsidiary Strategic Role

The task of relating information technology to international concerns and strategic choices was made tractable by accepting Mandell's (1975) premise that foreign subsidiaries constitute a basic building block of the international organizational structure, and his related assertion that it was therefore appropriate for researchers to focus on the interface between headquarters and foreign subsidiaries to determine the nature of international information systems. The most directly useful treatment of subsidiary strategic role comes from the suggestion by Gupta and Govindarajan (1991) that subsidiaries can be differentiated by their value chain configurations. Building on Porter's (1986) value chain configuration and Root's (1987) entry mode discussion, they suggested a research focus on the four most common subsidiary arrangements of value chain activities: purely marketing, purely manufacturing, combined manufacturing-marketing, and full value chain. The following sections describe the information requirements associated with each of these subsidiary arrangements.

Marketing Subsidiary. The role assigned to this category of subsidiary was to market into the local trading area products that were manufactured elsewhere, perhaps centrally. Process and product development also occurred elsewhere. The subsidiary activities ranged from simple importing to sophisticated marketing with extensive distribution, advertising, sales and customer support services. Earl (1989) considered the information technology requirements of this type of subsidiary to be limited to responding to user requests for inventory management or value-added product information.

Marketing-Manufacturing Subsidiary. This variety of subsidiary had the assigned role as a product specialist that produces and markets a limited product line. Similarities in products, markets or basic technologies with headquarters resulted in frequent data communication exchanges between headquarters and the subsidiary. The subsidiary was self-sufficient in terms of the value added aspects of the product with strategic control over established products. Roth and Morrison (1990) contended that this strategic role involving broadening the scope of the service to the local market resulted in a critical need for database management systems that integrated both headquarters and subsidiary data requirements for the provision of both sales and product specific information.

Full Value Chain Subsidiary. Fully capable of performing research and development activities in addition to marketing and manufacturing, this class of subsidiary acted as a miniature replica of the parent corporation and had the freedom and resources to develop entire lines of business. The relationship with headquarters ranged from roles in which administrative and financial relations were the principal link to a role as an innovator that contributes substantial knowledge to the entire firm. Roth and Morrison (1990) labeled this strategy as complex innovation and contended that the corresponding information technology requirements included: computer-aided design for product development and flexible manufacturing systems. Considering the leading edge nature of these tools, we expected to find lower levels of the physical architectural elements such as computing compatibility, data transparency, communications connectivity and applications functionality.

Manufacturing Subsidiary. This category of subsidiary produced a designated set of component parts or complete products for either a single country or an entire global market. As a subsidiary operation, the product scope was limited with marketing and product development activities undertaken by the headquarters unit. Egelhoff (1991) suggested that more advanced, non-hierarchical information technology systems were needed in order to connect these foreign subsidiaries to the center of product knowledge in domestic product divisions.

In sum, this conceptual framework suggests that the competitive use of information technology in international business involves issues characterized by a broad scope and enormous inherent complexity. The concept of subsidiary strategic roles provides a finite set of information technology requirements. A useful research perspective on the information technology capabilities is presented in the next section.

RESEARCH PERSPECTIVE

The adoption of an architectural approach to information systems development has been recognized by several researchers (e.g., Brancheau and Wetherbe 1987, Latham 1990, Allen and Boynton 1991, Watson and Brancheau 1991, Keen 1991), as a key issue for information systems researchers during the next decade. Earl (1989) concisely reasoned that an architecture was necessary as an information systems framework that provided a technological model of the organization for designing interfaces, compatibility and integration.

By utilizing an international information technology architecture descriptive typology, developed and validated by Gibson (1992), the proposed linkage between subsidiary strategic role and information technology architectures can be examined. The international information technology architecture construct can be considered a high-level map of the information technology capabilities of a global entity composed of physical elements of computing technology, data, communications, and applications inclusive of logical elements of planning, organizing and controlling. Given the desire to compare international information technology architectural capabilities with global business requirements, the following sections present characterizations of these four generic architectural types with regard to their associated information processing capabilities.

Type I Architecture Capabilities. Low levels of computing compatibility, data transparency, communications connectivity and applications functionality characterized the physical elements of the Type I architecture. Egelhoff (1991) contended that the resulting, limited information processing capabilities were appropriate only for transmission of financial data and for decisions such as a routine price change on an existing product. In terms of the logical architectural elements, the planned objectives for information technology center on measurable financial benefits such as cost reduction. Information technology has no strategic impact here because related opportunities or threats are not yet perceived. Organization is by a back-room information technology department, and not formally noticed by higher level managers.

Type II Architecture Capabilities. The lack of agreement in the research literature required characterization of the Type II architecture by its logical elements. The elevated status and influence of information technology planning and organization mirror the perceived importance of information technology to the firm's current and future business. Allen and Boynton (1991) explained that such a high-investment architectural extreme was capable of serving as a catalyst for change. More specifically, Earl (1989) suggested that if information technology is central to creating new opportunities, then efforts are needed to re-orient information systems to the pursuit of innovation. Unfortunately, this results in several global systems co-existing, each tailored to local language and other regional needs. The belief that only line, rather than staff, management can recognize new competitive opportunities forced the information technology function to be organized on a par with other business functions.

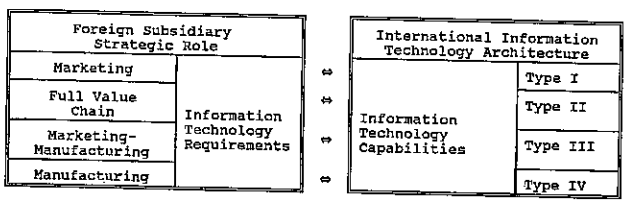
Type III Architecture Capabilities. This architecture type reflects the firm's dependence on the stable and reliable automation, information processing and communications capabilities that are made possible by information technology. Earl (1989) suggested that under these conditions technology solutions are conventional, pragmatic and follow *de facto* industry standards. Consequently, moderate levels of computing compatibility, data transparency, communications connectivity and applications functionality are expected for the physical elements of this architecture. In terms of the architecture elements, the need for reliability made technological risks inappropriate. Consequently, recognizable, moderate-level, logical architecture elements would include: resource-based planning, budget-based control, and positioning of the information technology department as a recognizable position on the corporate organizational chart.

Type IV Architecture Capabilities. With information technology embedded in a core business activity, such as manufacturing, a firm can be classified in McFarlan's (1984) strategic quadrant and can be expected to seek information technology opportunities to achieve the flexibility needed to adapt to new, dynamic environments. Thus, the information technology architecture, by definition, must be integrated with business plans. Traditional, tidy responsibility and authority give way to hybrid arrangements, with high subsidiary autonomy designed to drive and develop integrated information systems. In an effort to limit associated technological confusion, organizations elevate information technology to top managerial levels in the organization. Adopting a "best practices" approach, ideal applications are identified and reengineered using automated development methodologies for worldwide adoption. The logical element of information technology planning becomes more intertwined with physical architectural elements due to concerns about interfaces, integration, compatibility and manageability.

RESEARCH MODEL

The general research model portrayed in Figure 1 was as the basis for specific research propositions. This model adopts Egelhoff's (1988) call for translating strategic and environmental conditions and organizational design features into their respective information processing implications in order to facilitate examination of the corresponding fit (⇔) between information technology requirements and capabilities as comparable phenomena. Thus, information processing theory provided the underlying logic and the conceptual glue that holds the model together, while specific constructs and their operationalizations were drawn from the significant research literatures.

Figure 1: General Research Model



As denoted in the above model, the focus was on the matching (⇔) of the explicit information technology requirements of each of four subsidiary strategic roles with the distinct information technology capabilities of each of four international information technology architectures. The foreign subsidiary strategic role was treated as a construct derived from the business information processing requirements of an international firm. In other words, the left-hand side of the model served as an expression of the idea that a globally competing organization's strategy and the international contextual factors it chooses to deal with can be represented by the information processing requirements these choices created. Similarly, the right-hand side of the model portrays the information technology architecture construct as derived from the organizational structure and technological infrastructure. Thus, the information technology architecture construct served to delineate four alternatives for providing information processing capabilities.

The model proposes a matching (⇔) of the information technology requirements of each of four subsidiary strategic roles with the distinct information technology capabilities of each of four international information technology architectures. Pioneering information systems researchers advocating the organizational fit concept (e.g., Ein-dor and Segev 1982, McFarlan and McKenney 1983) argued that an organization must design its information technology systems to match or fit with organizational contextual variables. The proposed relationship between the information technology architectural capabilities and international business information processing requirements was evaluated using a configurational treatment of fit, described by Venkatraman (1989) as a conceptual matching between two variables, without regard for a performance measure. This treatment of fit is based on the premise that only those firms that match needs and resources will remain competitive.

Encouraged by preceding research efforts (e.g., Roche 1992, Karimi and Konsynski 1991) which suggested a "parallel" or a "fit" between information technology and business strategy, we proposed that an appropriate match between subsidiary strategic role and information technology architecture, with full consideration of international regional constraints, may maximize the effectiveness of firms operating in the global arena. This discussion could be succinctly compressed into the four testable research propositions presented here:

> Proposition 1: In the absence of regional constraints, an international firm with a foreign marketing subsidiary will utilize a Type I architecture as the most appropriate fit of information technology capabilities with the requirements for headquarters-subsidiary interaction.
>
> Proposition 2: In the absence of regional constraints, an international firm with a foreign full value chain subsidiary will utilize a Type II architecture as the most appropriate fit of information technology capabilities with the requirements for headquarters-subsidiary interaction.
>
> Proposition 3: In the absence of regional constraints, an international firm with a foreign manufacturing-marketing subsidiary will utilize a Type III architecture as the most appropriate fit of information technology capabilities with the requirements for headquarters-subsidiary interaction.
>
> Proposition 4: In the absence of regional constraints, an international firm with a foreign manufacturing subsidiary will utilize a Type IV architecture as the most appropriate fit of information technology capabilities with the requirements for headquarters-subsidiary interaction.

These propositions provided full consideration of international regional constraints that may impact the architectural choices of firms operating in the global arena. The specifics of the research methodology employed for empirically testing the propositions are presented in the next section.

RESEARCH METHOD

The guidelines for this research design came from a report by Kraemer and Dutton (1991) that recognized survey research as the most widely used (36% of journal articles and 34% of dissertations), but also the least understood method employed by information systems researchers. By limiting the focus of our analysis to the headquarters-subsidiary dyad as the unit of analysis, we alleviated confounding concerns related to organization size and the complexity resulting from the occurrence of a variety of information technology systems and structures even within a single firm.

Adapting the steps developed by Kerlinger (1964), we used a multi-step process for questionnaire development in order to maximize the reliability and validity of the results. As Step 1, constitutive and operational specification of the domain of the construct preceded any attempt to develop survey questions. For Step 2, we reviewed the existing literature concerning information systems surveys on the premise, supported by Lucas (1991), that concerns about validity could be substantially reduced by the use of survey questions that were previously judged as valid. The literature review provided a source for potential questionnaire items and scales, as well as methodological treatments from related research efforts. These pre-existing questionnaire scales were modified to improve their international incisiveness. For Step 3, pretests of the survey instrument were conducted. A prototype questionnaire was provided to the eight information technology and functional executives whom we had previously interviewed, and these executives were asked to evaluate the questionnaire wording in terms of comprehension and content validity. The pretest measures provided both refinement of the questionnaire items and confirmation of content validity.

The survey questionnaire was initially mailed to an identified senior information technology executive for two hundred and seventy two American firms. We anticipated that firms would have many subsidiaries, each with unique strategic roles and corresponding information technology resources. In consideration of this, and to maximize variability in responses, each survey participant was instructed to consider two typical foreign subsidiaries with information technology linkages to corporate headquarters that differed from one another in their strategic role, information technology sophistication and/or geographic location. The final response rate was nearly 23% and a final contact rate (including a final total of thirty four firms declining participation) was 35%.

TESTING OF PROPOSITIONS

Finding support for the initial conjecture regarding the generic architectures, several types of analysis were used to examine the matching between information technology architectures and subsidiary strategic roles. Table 1 displays the results of our use of the Chi-square test of independence to evaluate the significance of the differences between the frequency of firms that reported a match between the information technology architecture and subsidiary strategic role and the expected distribution based on our propositions. It was expected that, in a perfect world under ideal conditions, the majority of the firms would fall along the diagonal (bold values) in Table 1 because of the hypothetical expectation that rational managers would strive for a fit between subsidiary strategic role and an appropriate information technology architecture types. Nevertheless, the mismatches (i.e., values not along the diagonal) came as no surprise given the existence of internal strategic factors and uncontrollable factors in the external international environment. As anticipated, many of the mismatches fell below the diagonal in support of the premise that the international environment constrains firms and forces a choice of suboptimal information technology architectures. These international constraints will be discussed in the next section of this paper.

Table 1: Chi-square Test Results	Type I	Type II	Type III	Type IV
Marketing	**11**	2	17	1
Full Value Chain	0	**6**	13	11
Marketing-Manufacturing	2	3	**19**	3
Manufacturing	6	0	14	**5**
$\chi^2 = 32.109$, $p = .0002$				

Among the subsidiaries, the mismatches fell into two broad groups, those with information technology architecture types characterized by less than adequate capabilities and those with types characterized by capabilities in excess of anticipated requirements. International constraints, as possible reasons for the less than adequate mismatches, were examined within the context of the relationship between information technology architectural capabilities and subsidiary requirements.

Marketing Subsidiary Mismatches. By design, the marketing subsidiary was paired with the minimal international information technology architecture, Type I, and therefore cannot be evaluated regarding the adverse impact of international constraints. Most of the mismatched marketing subsidiaries (17 of 20) were classified as Type III architectures. Interestingly, this created the implication that, in international environments, marketing subsidiaries can be expected to employ information technology architectures that exceed their information processing requirements. By adopting the premise that the expected evolution of international firms would proceed naturally from Type I to Type III, the relatively high number of marketing subsidiaries with Type III architectures in place might well imply a proactive anticipation of the trend toward increasing information needs in the global environment.

Full Value Chain Mismatches. Eleven (37%) subsidiaries utilized Type IV architectures. This suggestive finding hinted at the possibility that the Type II architecture and full value chain role each serve as a transitional, rather than permanent configuration for firms evolving globally, thus further accounting for the relatively high total number of both Type III and Type IV occurrences in the sample.

Marketing-Manufacturing Subsidiary Mismatches. Of the twenty-seven subsidiaries in this category, the majority (70%) utilized Type III architectures, as expected. The remaining subsidiaries were evenly distributed among the three other architectural types. The presence of only two subsidiaries with Type I architectures suggested a minimal influence of international constraints on the elements that provided the capabilities for this subsidiary strategic role. The six subsidiaries with architecture types with excess requirements may be due to a perception of information technology requirements based on a technology-push kind of demand.

Manufacturing Subsidiary Mismatches. For this proposed pairing with Type IV architectures, the relatively large number of mismatched subsidiaries suggested two plausible inferences. First, the large number (56%) of subsidiaries with Type III architectures may indicate that the local manufacturing requirements predominate so, as yet, there are no additional perceived requirements for synergistic value-chain combinations of manufacturing, marketing and research and development activities. A second inference, regarding the six (24%) observed Type I architectures, returns to our findings about international constraints as reasons to expect this situation. The foreign subsidiaries may have chosen to use different computers (lower compatibility) and applications (lower functionality) due to differing stages of maturity, diversity in products and markets, or the unavailability or infeasibility of certain computer systems in some foreign locations. Based on our findings related to international constraints, we speculated that these international constraints might account for these mismatches.

In sum, the survey results suggest the importance of environmental constraints. Until this point, data analysis has proceeded in a univariate and bivariate manner in complete conformance with the research model. Although the Chi-square test remains the accepted response for a test of independence but does not permit systematic evaluation of the relationship among the variables. Thus, multivariate techniques were used to test the effect of international constraints on the relationship between the information technology architecture and the subsidiary strategic role and the results are presented in the next section.

STATISTICAL TEST OF INTERNATIONAL CONSTRAINTS

A thorough literature review suggested that important factors constraining the strategic choice of the information technology architecture in the international environment included the following five constraints: hardware restrictions, vendor limitations, cultural differences, substandard telecommunications, and applications idiosyncracies. Davidson and McFetridge (1985) tested hypotheses regarding international technology transfer using a special case of log linear regression, a logit model, that allowed them to identify the technology, parent and country conditions that increased the probability of internal versus external technology transfers to subsidiaries. Thus, for our purposes, rather than trying to isolate the singular effects of international constraints, we predicted the effect of a number of environmental variables on the occurrence of the matching of information technology architectures and subsidiary strategic roles. From the knowledge of whether or not the match occurred under the conditions of various international constraints logit analysis was used to estimate the probability that such matches will occur determined the statistical significance of the estimated coefficients. The natural logs of the cell frequencies are used in the log linear model rather than the actual counts as in the above Chi-square analysis. Our use of logit models was to test whether the occurrence of an architecture-strategy match was independent or whether the linkage was adversely affected by international constraints such as: restrictions on hardware acquisitions, lack of vendor support, transborder data flow restrictions, telecommunications infrastructure, and currency conversion and exchange rate applications idiosyncracies.

Recall that survey data results indicated that forty-one subsidiaries, a ratio of 41/72 had a match between information technology architecture and subsidiary strategic role. Table 2 provides the lambda coefficients, obtained by using a non-linear maximum-likelihood estimation procedure, for each of the international constraint parameters and the calculated log ratio of match/mismatch.

Table 2: Logit Analysis of International Constraints				
Constraint	Z-value	Main Effect (match)	Interaction Effects of International Constraints	
			Low effect	High effect
Restrictions on hardware acquisitions	2.556*	.33459	-.03084 1.83	-.30375 1.06
Lack of vendor support	3.049*	.33464	-.04642 1.78	-.28822 1.09
Transborder data flow restrictions	1.939	.22045	.18197 2.24	-.40243 0.69
Telecommunications infrastructure	2.981*	.29958	-.06269 2.06	-.36227 0.88
Currency conversion and exchange rate volatility	2.099*	.22849	.19515 2.33	-.42364 0.67
Significance * $p < .05$				

Overall, the findings supported the expectation that, within the international environment, several factors act to constrain attempts to match of information technology architecture and subsidiary strategic role. The probability of such a match was significantly greater in the absence of the international constraints. Possible explanations for the observed patterns are addressed in the following sections which summarize the logit model predictions.

Hardware Restrictions. Regarding the possible effects of hardware restrictions such as import barriers or local product use requirements, the log ratio of a low effect equals 1.83 and the log ratio for a high effect equals 1.06. It is possible to use these values to predict the probability of match of the information technology architecture and subsidiary strategic role under each of these two extremes. The log ratio value of 1.83 for a low effect allows us to infer that under conditions of minimal constraints on hardware acquisitions for the foreign subsidiary there is a greater probability that a predicted match between the information technology architecture type and the subsidiary strategic role will occur. More specifically, the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 73/40. In like manner, the log ratio value of 1.06 for high effect allows us to infer that under conditions of high constraints on hardware acquisitions the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 58/55. Thus, we have discovered empirical evidence to support the idea that hardware restrictions act to constrain the information technology architectural choices.

Vendor Support. The log ratio of a low effect equaling 1.78 suggests that under conditions of low adverse effects due to the availability of vendor support the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 72/41. In like manner, the log ratio value of 1.09 for a high effect suggests that under adverse conditions due to the unavailability of vendor support the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 59/54.

Transborder Data Flow Restrictions. Although not quite significant at the 95% confidence level, this lambda coefficient fell very close to the Z-value cut-off of 1.96 and therefore merits some explanation, especially in consideration of the numerous references to this issue in the research literature. The log ratio of 2.64 corresponding to a low effect suggest that under conditions of low restrictions on transborder data flows the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 82/31. In like manner, the log ratio value of 0.69 suggests that under conditions of high restrictions on transborder data flows the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be a relatively low ratio of 46/67.

Telecommunications Infrastructure. The log ratio of a low effect equal to 2.06 suggests that under conditions of low adverse effects associated with telecommunications infrastructure the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 76/37. In like manner, the log ratio value of 0.88 for high effect suggests that under conditions of a high adverse effect due to a poor telecommunications infrastructure the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 53/60.

Currency/Exchange Rate Volatility. The log ratio of a low effect equal to 2.33 suggests that under conditions of low effect for this constraint the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 79/34. In like manner, the log ratio value of 0.67 for high effect suggests that under conditions of a high effect for this constraint the predicted odds ratio of match/mismatch for our sample of 113 subsidiaries would be 45/68.

DISCUSSION OF FINDINGS

It was especially appealing to examine these results in light of the criticism of the information systems profession as too often developing systems which only reflected the *status quo* and thus failed to anticipate future requirements. Previously, information systems researchers relied on stages of growth models such as those offered by Nolan (1979) and Earl (1989). The narrow focus of these models precluded consideration of strategic and international contextual factors. Our results suggested the value of a wider focus for identification of both optimal and feasible information technology architectural choices. Importantly, our last "stage," i.e., Type IV, does not represent an ultimate goal toward which all globally competing organizations should aspire.

The empirical support found for specifying the nature of the linkage between information technology architectures and international business should overcome two problems commonly found in practice. One, information technology executives could use the results to obtain the commitment and involvement of senior business managers by showing that the business and technology aspects of the information-related issues have similar future paths. The empirical discovery of the need for information technology to evolve along with business strategies can proactively serve to refine the concept of information technology planning as a continuous, learning process that rightfully belongs as a continuing part of managerial concentration. Second, the results confirmed that although it may be appropriate in the longer term to utilize advanced, complex information technology capabilities; the current and future organizational requirements may not yet warrant the associated costs and risks.

These empirical findings suggested that information technology can no longer be managed as a support type of activity for international firms. Instead, information technology must be an integral part of overall business planning in order to enable coordination and cross-functional linkages. Furthermore, to create competitive advantage in international environments, product development and marketing value activities enabled by information technology must adopt the principles of integration rather than the individualistic efforts of traditional computer applications. Finally, if the firm's technology infrastructure is to support and/or enable globalization, then information technology management must be concerned with strategic change, global awareness and integration needs.

A natural extension of this work is to conduct of a study of foreign firms with American subsidiaries. Presently, it is unclear whether the highly sophisticated and unregulated nature of the computer and telecommunications industries in America will be the primary determinant of architecture choices, or whether foreign management policy and practice will be the controlling determinant. A second natural extension of our subsidiary focus is the examination of international information technology architertures for inter-subsidiary and inter-organizational structural arrangements.

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