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The impact of industry contextual factors on IT focus and the use of IT for competitive advantage

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Abstract

Only limited empirical evidence has confirmed the effectiveness of strategic information systems planning (SISP) and there is no evidence that investment in mission-critical systems leads to improved performance under conditions of environmental uncertainty and information intensity. This study tests the extent to which such contextual factors impact business dependence on IT and two SISP practices: IT participation in business planning and the alignment between the IT and the business plans. It also examines the influence of IT dependence and SISP on the use of IT for competitive advantage. Using structural equation modeling on postal survey data from 161 firms, it found a positive and significant impact of the contextual factors on business dependence on IT and the two SISP practices and between these factors and the use of IT for competitive advantage. Data also revealed significant differences between industry types and environmental uncertainty but not information intensity. Implications are discussed.

Keywords: Environmental uncertainty; Information intensity; Strategic information systems planning; Competitive advantage; Structural equation modeling

1. Introduction

Recent surveys of CEOs have shown that, despite numerous failed investments, information technology has assumed a critical and strategic role in their organizations [16]. For IT to fulfill that role, CIOs undertake strategic IS planning (SISP), a time-consuming and costly process. Observers have questioned the value of such formal planning methods, particularly in changing environments. Despite the increasing information intensity of most organizations, only limited evidence supports the effectiveness of SISP in these environments [79].

At the same time, many businesses have become highly dependent upon IT to support numerous core activities to the extent that failure of these systems would critically impair the firms [9]. This large increase in IT investments and business dependence on IT over the past two decades raises several questions.

- Are SISP practices valid under conditions of environmental uncertainty?

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- Should information-intensive firms engage in SISP?
- Is business performance affected by dependency upon IT?
- Is business performance affected by the use of formal IT planning methods?

Critics of SISP state that formal methodologies are too rigid to be effective in responding to the changing marketplace conditions of uncertain environments [58]. However, research has shown that rational decision-making processes can be appropriate under such environments [76], various organizational factors predict the quality and effectiveness of SISP, and that formal planning approaches are more successful [68].

Both environmental uncertainty and information intensity have been identified as important industry contextual factors that impact the role of IT in creating a competitive advantage [39]. These factors can influence the effectiveness of planning mechanisms and the firm's ability to earn adequate returns on IT investments. By examining the effectiveness of SISP within the context of environmental uncertainty and information intensity, we gain further understanding of how context influences the relationship between SISP and the competitive use of IT and gain insight into whether increased reliance on IT for core activities has any impact on business performance. The purposes of this study were therefore to examine:

(1) the impact of environmental uncertainty and information intensity on business dependence on IT;
(2) their impact on SISP practices;
(3) the impact of business dependence on IT and SISP practices on the use of IT for competitive advantage; and
(4) the influence of industry on the contextual variables.

2. Development of the conceptual model

2.1. Contingency theory

Contingency theory, which forms the basis of our study, states that in order to take advantage of organizational opportunities, management must find a proper fit among key variables including environment, strategy, technology, and size [47]. We further assumed that environmental uncertainty and information intensity influence firm dependency on IT and SISP planning and, thus, its ability to create a competitive advantage.

Contingency theory was developed and successfully tested in the strategy literature [22] and strategic contingency theorists maintain that an appropriate fit between environment and strategy will result in superior organizational performance. Performance might be reflected in several ways: by profitability and growth relative to competitors, or by the competitive use of IT (as in the use of inter-organizational systems or introduction of switching costs). Simply stated, organizations that provide greater value will reap the rewards while firms that perform poorly will be induced to realign their strategies with the environment [88].

2.2. Environmental uncertainty and information intensity

Industry contextual variables have significantly influenced MIS research; e.g., researchers have examined how the fit between strategy and the environment can influence organizational performance [54]. Miller found that a proper match between the environment and strategy was related to performance, particularly in information-intensive industries [55]. Businesses in these industries adopt and become dependent on IT systems to respond to environmental change.

Prior research has also linked environmental uncertainty and information intensity with the success of strategic IT investments [71]. Uncertainty expands the role for IS planning and heightens the need for organizational structure and integration [44]. Information-intensive industries are more apt to use IT for strategic benefits and initiate business process improvements. Companies in information intense industries must continually seek out ways to manage and exploit their IT assets [30].

However, despite its acknowledged importance, empirical research has failed to show a significant relationship between environmental uncertainty and SISP; Teo and King failed to find a significant relationship between environmental uncertainty and the integration of the IT and business plans [85]. A study of 58 firms in northern California found that SISP did not modify the impact of environmental uncertainty on

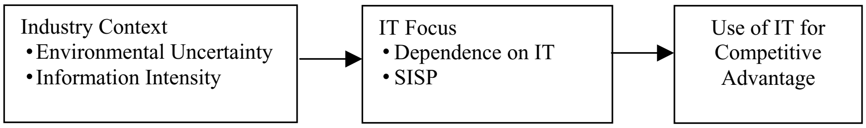

Fig. 1. Contextual relationship of IT focus and use of IT for competitive advantage.

IT-based competitive advantage [42]. Our study hypothesized that environmental uncertainty and information intensity impact the IT focus of the firm and that this has a direct relationship on organizational performance as shown in Fig. 1.

2.3. IT focus: business dependence on IT and SISP

Here, we define IT focus as organizational commitment to mission-critical IS and their management and control. IT focus is represented by the combination of business dependence on IT for core activities, IT participation in business planning, and IT-business plan alignment. Dependence on IT increases with both environmental uncertainty and information intensity. This dependence focuses the firm's attention on the potential to be gained by crafting IT investments that support and enable business strategies.

Investments in IT should be those that support business objectives and significantly affect organizational performance [78]. Hence, information intense firms should value IT as a strategic resource. CIOs should follow SISP practices. They should participate in business planning so they understand changing business directions and revise IT priorities accordingly [49], and align IT plans with business plans in order to improve organizational performance [77].

SISP has consistently been identified as a key issue facing management [8,59]. SISP implies a formal approach, as opposed to an adaptive, reactive or informal approach to planning. For organizations characterized by environmental uncertainty and information intensity, we suggest that SISP better promotes the use of IT for competitive advantage. Otherwise, formal IT planning is simply a resource drain and its continued use should be reevaluated.

SISP is necessary in order to make sure that IT is used effectively to meet future business initiatives and competitive challenges [72]. This alignment may be the result of a formal planning system but can also occur from an accumulation of strategic decisions made incrementally over a period of years. Rational processes are proactive and include establishing goals, seeking and prioritizing alternative solutions, and developing an integrated plan to achieve goals derived from an established process. In contrast, incremental processes are more reactive and reflect informal modes of participation, communication, and decision making to achieve a desired outcome.

Ansoff has argued that environmental uncertainty has made it more difficult to achieve alignment via formal planning systems and Mintzberg advocated an 'adaptive' planning approach in unstable environments to take advantage of managerial agility and allow opportunistic responses [3,57]. Fredrickson and Mitchell showed a negative relationship between planning rationality and performance in one highly unstable industry [27].

Researchers have often viewed planning as being either formal or informal, whereas, in reality, organizational planning lies somewhere between these extremes. SISP, criticized as being too rigid in dynamic environments, can inhibit management agility and opportunistic behavior. Informal planning favors widespread participation and communication over complex analysis but may fail to include important alternatives and result in the selection of less effective technologies. In our study, both SISP constructs contained items that reflect both formal and informal elements in order to support adaptability and agility to ensure correct implementation.

2.4. Use of IT for competitive advantage

Past work has attempted to link IT investment and business performance with only limited success. Examples include improvement in the firm's ROI [89], pretax profits and sales growth, profitability, internal rate-of-return, and cost-benefit ratio [20]. Strassman, in a number of studies, was unable to find significant correlations between IT spending and sales growth, effectiveness, quality, or productivity and concluded that IT investment could not be linked to profitability [82]. Subsequent studies revealed that a large number of uncompetitive organizations had made large investments in IT [83].

Although some efforts have shown a link between IT investment and financial performance, it is indirect and complex [50]. This is because of the difficulty in controlling variables that impact profitability [12]. Problems in directly associating IT investments with financial performance render such measures of performance inadequate as dependent variables.

IT-based competitive advantage may be achieved via inter-organizational links with suppliers and customers, by leveraging unique firm capabilities, lowering product costs, and creating product differentiation [15,66]. CIOs have ranked the use of IT for competitive advantage as a top priority [24]. The sustainability of competitive advantage has been called into question because information resources can easily be acquired and systems replicated [43]. Other research supported the heterogeneity of IS and viewed superior information capabilities as means of providing sustainable competitive advantage. Our study does not address the question of sustainability. The use of IT for competitive advantage represents IT applications and support for business initiatives for which companies have already reported advantages and that theory suggests will provide organizational benefits.

3. Hypotheses

3.1. Environmental uncertainty and IT focus

Environmental uncertainty creates the need for greater innovation and product differentiation requiring a higher level of dependence on IT [74]. Uncertainty places time constraints upon decision-making and forces companies to invest in technology for coping mechanisms. Decision-makers, for example, may turn to more sophisticated information analysis such as group collaborative support systems and data mining [34]. As more systems are adopted to support core activities, IT dependence increases.

An uncertain business environment also requires more management attention in order to make sure the business direction is aligned with external changes. This heightens the need for greater IT participation in business planning as IT managers attend planning meetings and communicate with other managers to understand organizational level responses to these changes [38]. A recent study of over 200 manufacturing executives revealed that wider participation in planning lent adaptability and achieved higher congruence between SISP and market needs [62].

Greater environmental uncertainty also implies a need for constant alignment of the IT plan with the business plan to ensure that IT resources continue to support business strategies and take advantage of emerging opportunities; one response is the integration of business processes and decision-making support [87]. This context would heighten the need for IT alignment with the business plan. Hence, the following hypotheses.

H1. Environmental uncertainty is positively associated with:

a. business dependence on IT;
b. IT participation in business planning;
c. the alignment of the IT plan with the business plan.

3.2. Information intensity and SISP

Information intensity, the extent to which products and processes incorporate information, has been identified as an industry factor with important implications for management [18]. Information-intensive industries have demonstrated superior abilities in using IT to support core activities and identifying strategic opportunities [6]. Companies in these industries would thus be expected to become more dependent on IT for core processes [29].

IT managers acquire business knowledge by attending business planning meetings and talking to business managers [48]. Since companies with products and services characterized by high information intensity are more likely to value IT, information intensity will lead to higher levels of IT participation in business planning.

Information content in key activities can be used to develop competitive IT systems. Products and services that are information-intensive should be viewed as business assets that increase the value of SISP [52].

Complex products, and operations involving complex products and services, have higher information requirements than simple products [73]. In such cases, increased information content requires that the IT strategies be specifically aligned with the business strategies. Hence, the following hypotheses.

H2. Information intensity is positively associated with:
a. business dependence on IT;
b. IT participation in business planning;
c. the alignment of the IT plan with the business plan.

3.3. IT focus and the use of IT for competitive advantage

In our study, the measurement of IT performance at the business level was the use of IT for competitive advantage. Positive relationships between IT focus constructs and the use of IT for competitive advantage would thus imply that dependence on IT and SISP practices impact business performance.

Dependence on IT can evolve over time as companies use diverse IS to differentiate products, create switching costs to retain suppliers and customers, exploit unique firm capabilities, impose barriers to market entry, create competitive advantage, or counter another firm's competitive advantage [37,65]. These systems can generate cost reductions, support competitive positioning, and allow the firm to compete in new ways. As companies become more dependent on them to process daily transactions, they become critical to the survival of the firm.

IT participation in business planning is necessary in order to search out inter-organizational opportunities for competitive advantage, seek IT-based opportunities in value chain activities, and use IT to leverage unique business strengths [14]. The CIO's chief concern is not with technical matters, but on how to use IT to improve business processes. Higher IT participation in business planning will increase the mutual sharing of information and IT investments will be more likely to reflect the strategic direction of the firm and improve performance [69].

Alignment between the IT and business plans is necessary in order to accomplish business objectives and capitalize on information technologies [45], help make certain that IT investments properly support the firm's objectives, and increase the use of IT for competitive advantage. For example, different types of inter-organizational systems need to be linked to specific business strategies although they share common infrastructures [35]. Hence, the following hypotheses.

H3.
a. business dependence on IT . . .;
b. IT participation in business planning . . .;
c. alignment of the IT plan with the business plan . . .
is positively associated with the use of IT for competitive advantage.

3.4. Relationship of contextual variables with industry type

Environmental uncertainty and information intensity have been important contextual variables in MIS contingency research. Surprisingly, however, industry differences in response to these variables have rarely been examined despite research that implies that industry context can impact organizational adaptation. Different industries possess distinguishing characteristics that should be addressed by management [36]. This suggests that adoption of internal practices, such as the reliance on IT systems and SISP, will be guided by responses to these external issues.

Research has frequently concentrated on practices within a single industry. For example, Andersen and Segars examined the performance impact of IT in the apparel industry and found that firms that used IT to enhance communications were more successful [1]. However, it has been assumed that the generalization of findings from a single industry is more restrictive than for a larger representation. Also, industry characteristics may be shaped by IT. In their examination of the airlines, wholesale drugs, and industrial chemicals industries, Segars and Grover found that industry characteristics were altered by the adoption of competitive IT practices [80]. The contention, then, is that differing characteristics will result in differing values for the contextual variables. Thus, we expected the values in some industries to be significantly different from others. This leads to the following hypotheses.

H4. Industries will exhibit differing levels of environmental uncertainty.

H5. Industries will exhibit differing levels of information intensity.

4. Operationalization of constructs

Here, two constructs, environmental uncertainty and information intensity, represented industry contextual factors. Three constructs were used to signify IT focus: one represents business dependence on IT and two represent practices that facilitate SISP. The two SISP practices were IT participation in business planning and the alignment of the IT plan with the business plan. A sixth construct, the use of IT for competitive advantage, served as the dependent variable. Based on contingency theory and research from environmental uncertainty and SISP, the conceptual model in Fig. 2 shows the relationships that form the first nine study hypotheses.

While our model posits a direct relationship between the contextual variables and IT focus, it could be argued that the true relationship is a mediating one through IT dependence. Others might also argue that information intensity promotes IT dependency, which consequently leads to higher SISP. However, existing theory supports the relationship between environmental uncertainty and alignment. Furthermore, companies have been shown to increase their dependence on information resources as a response to external pressures. When competition is characterized by information intensity, companies would be expected to increase both dependence upon IT and practices that promote the rational use of these resources. Thus, SISP could proceed directly from both environmental uncertainty and information intensity.

4.1. Environmental uncertainty

Researchers have long considered environmental uncertainty as increasing the importance of information processing capability in the organization [28]. One dimension of environmental uncertainty is the presence of heterogeneity: i.e., the measure of the diversity in the external environment [23]. It refers to the external threat posed by diversity in customer buying habits, product lines, and the nature of competition. Greater diversity creates structural challenges that can be met by the integrative and communicative abilities of IS that support strategic decision-making [56]. Three items, shown in Table 1, were used to operationalize the environmental uncertainty construct. These had been tested in previous instruments.

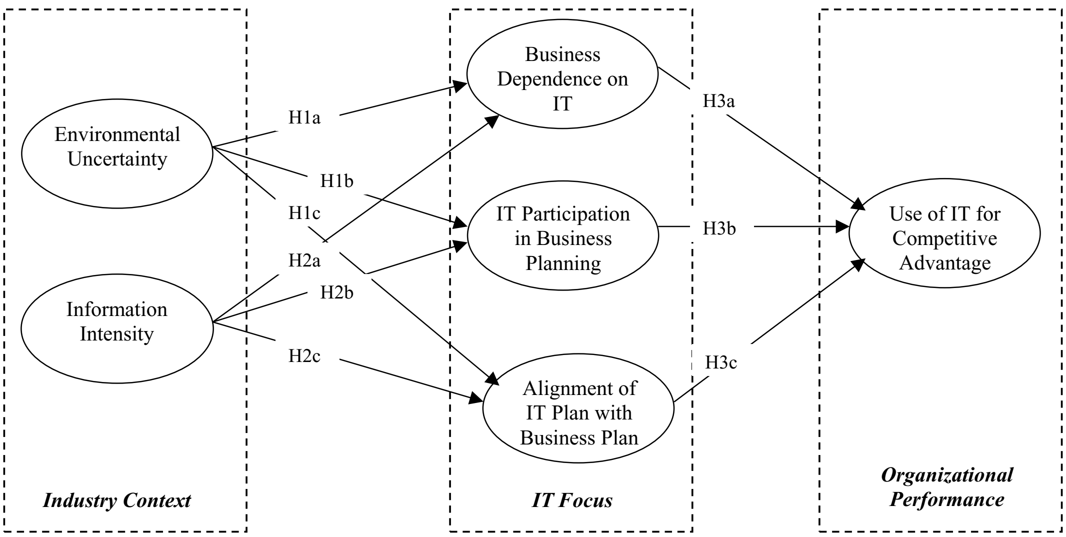

Fig. 2. Conceptual model.

Table 1
Items used to measure study constructs (from study survey)

Environmental uncertainty	In our industry, there is considerable diversity in ...
ENV1	... customers' buying habits
ENV2	... the nature of competition
ENV3	... product lines
Information intensity of the value chain	
INT1	Information is used to a great extent in our production or service operations
INT2	Information used in our production or service operations is frequently updated
INT3	Information used in our production or service operations is usually accurate
INT4	Many steps in our production or service operations require the frequent use of information
Business dependence on IT	In regard to existing information systems ...
DEP1	A one hour shutdown of computers would have serious consequences
DEP2	Programming errors could have serious consequences on customer satisfaction
DEP3	It is not feasible, in the short-run, to operate the business manually in the absence of our computers
DEP4	The daily operations of the business are critically dependent on IS
DEP5	We have many critical on-line or batch information systems
IT participation in business planning	The IS executive
PAR1	... regularly attends business planning meetings
PAR2	... contributes to the formulation of business goals
PAR3	... has regular informal contacts with top management
PAR4	... has easy access to the CEO
PAR5	... has frequent contacts with the CEO
Alignment of IT plan with business plan	
ALN1	The IS plan reflects the business plan mission
ALN2	The IS plan reflects the business plan goals
ALN3	The IS plan supports the business strategies
ALN4	The IS plan recognizes external business environment forces
ALN5	The IS plan reflects the business plan resource constraints
Use of IT for competitive advantage	With respect to our company's core products or services and major customers and suppliers, IT has been used to ...
CA1	... provide advantages such as lower costs or product differentiation
CA2	... establish electronic links with suppliers or customers
CA3	... create barriers to keep competitors from entering our markets
CA4	... influence the buyer's decision to switch to our products
CA5	... leverage unique firm capabilities

4.2. Information intensity

A firm is information intensive "to the degree that its products, services, and operations are based on the information collected and processed as part of exchanges with customers, suppliers, and within the firm itself" [31]. A high level of information in value chain activities increases the likelihood that companies will identify opportunities for using IT resources for competitive advantage. Analysis of corporate spending on IT indicates that companies in the strategic and turnaround sectors of the strategic grid allocate more resources to the IT function than those who view IT as a support function. The information intensity of value chain activities has been measured by information usage, information update frequency, information accuracy, and the information dependency of operations.

Accuracy, timeliness of updates, pervasiveness, and frequency of use in production and service operations are attributes of information intensity. Based on these ideas, four items were used to operationalize the information intensity construct. These had been developed and tested in a previous instrument [84].

4.3. Business dependence on IT

When businesses use IT in core processes that are mission-critical, they become dependent upon them for survival and must manage the assets as an important investment [51]. Accuracy of data and up-time are critical. Even a temporary shutdown could be disastrous. Charles Schwab and Lehman Brothers, for example, are highly dependent upon distributed systems for on-line trading. The more systems that are mission-critical, the greater is business dependence on IT. Based on ideas suggested by Cash et al., five items were used to operationalize the business dependence on IT construct [11].

4.4. Rational adaptive planning

Planning adaptability can be built into the planning system through increased levels of participation and consistency [81]. This rational adaptive approach is represented by the combination of the formal and informal elements of SISP. Participation can support management agility and opportunistic behavior under changing environments when CIOs have frequent and easy access to business executives and meetings are informal. Similarly, strategic IT alignment can support adaptive behavior by reflecting external business forces. Formal methods of participation and alignment ensure that IT investments are directed at supporting organizational objectives, increasing the likelihood of using IT effectively and creating competitive advantages.

4.5. IT participation in business planning

Participation of IT in business planning refers to the extent that the CIO participates in and provides input to the firm's planning process and thus results in a mission statement, goals, and strategies. Business planning is more effective as a participative process involving all key managers. CIO participation is an effective integrating mechanism for bridging IT and business strategies and increasing planning effectiveness. Access to the CEO ensures that IT will know of evolving needs and changes in direction. Participation must occur in both formal and informal settings. The first two items (PAR1 and PAR2) reflect formal modes of participation while the last three items (PAR3, PAR4, and PAR5) reflect informal modes. Based on these ideas, five items were used to operationalize the IT participation in business planning construct.

4.6. Alignment of the IT plan with the business plan

The main purpose of SISP is to align the IT plan with the business plan. A recent survey of 200 Korean firms revealed that SISP practices were more likely to have strategic benefits in uncertain environments [13] where comprehensive IT planning is vital. For organizations that view IT as a strategic resource, the alignment between the IT and business plans is critical, and has consistently been identified as a key issue by CIOs and other executives [33]. Empirical research has frequently failed to find an association between alignment and business performance [61,63].

Alignment will include the transformation of the business strategy set to the IT plan, a strong linkage of IT objectives with business objectives, and an accurate assessment of the external environment [7,70,90]. IT planning, however, may be dependent upon prior IT success [75]. Based on this, five items were used to operationalize the alignment of the IT plan with the business plan construct.

4.7. Use of IT for competitive advantage

Efforts to link the use of IT to improved organizational performance have been compromised by the influence of other confounding variables. An alternative approach is to identify specific uses of IT that have been shown as having a positive impact [46]. For example, the use of IT to enhance internal communications supports a decentralized decision structure which directly impacts financial performance [86]. Accordingly, here the use of IT investments to create a competitive advantage is used as a proxy for organizational performance. Subjective measures have been used previously and have been shown to capture broad concepts such as organizational performance [19].

Porter identified three generic business strategies: product differentiation; cost leadership; and, focused or niche differentiation [64]. These counter five market forces: rivalry among existing firms; bargaining power of suppliers; bargaining power of buyers; threat of substitute products; and, threat of new entrants. McFarlan added information-based strategies: build barriers against new entrants; change the basis of competition; generate new products; build in switching costs; and, change the balance of power in supplier relationships [53]. Based on this, five items were used to operationalize the use of IT for competitive advantage construct.

5. Methodology

The research methodology was a field survey using a questionnaire with item measures grouped around each of the study constructs. In the late 1990s, surveys were sent to 1200 firms randomly selected from a list of over 12,000 US firms over all SIC codes but excluding government and non-profit institutions. The list was chosen because it included the full name and address of the CIO. A single digit number was randomly selected and, beginning with that company in the list, every 10th company was sampled.

For purposes of reliability, it was determined that the CIO was in the best position to respond to the survey questions. Directing questions to the most knowledgeable respondent often helps to overcome single source limitations [67]. Questionnaires were addressed directly to the CIO. In the cover letter, confidentiality was assured and a summary of findings was offered as an incentive for participation. Responses to survey questions were entered on a seven-point Likert-type scale as follows: Strongly Disagree, Mildly Disagree, Disagree, Neutral, Mildly Agree, Agree, and Strongly Agree.

5.1. Survey piloting

Four professors of MIS initially reviewed the survey and their recommendations were incorporated into the instrument. The revised survey was then piloted on four CIOs and four other members of top management from four different industries in a large mid-western city. Comments were positive and several suggestions were offered. The suggestions were incorporated into the final survey instrument.

5.2. Responses

After initially receiving 123 surveys in a 4-week period, follow-up phone calls were made to non-respondents. Information from these calls, shown in (Table 2), revealed that many surveys, following corporate policy, had been intercepted and discarded by secretaries before they reached the desk of the CIO. Other surveys had not been delivered because the CIO had changed positions or had left the firm. CIOs also expressed reluctance to provide information they regarded as confidential and several regarded academic surveys as low-priority items. After 8 weeks, usable surveys were received from 161 respondents from the sampling of 1200 firms (9 surveys with incomplete information were discarded). Surveys targeted at senior officers typically have lower response rates. The final response rate for this survey was 13%; this is relatively low and was attributable to the confidential nature of the survey items and corporate policies against answering surveys that resulted in about one-third of the surveys being undeliverable.

Table 2
Response to 500 phone calls

Action	Number of calls	
Either phone number changed or company no longer in business	24	4.8%
No direct contact. Left voice message explaining purpose of survey and requesting participation	119	23.8%
Direct contact with secretary or assistant explaining purpose of survey and requesting participation	138	27.6%
Direct contact explaining that the executive is no longer with the company. Permission granted to send new survey.	43	8.6%
Direct contact explaining that the executive is no longer with the company. Permission denied to send new survey	30	6.0%
Direct contact explaining that the company policy is against surveys	84	16.8%
Direct contact stating that they may or will complete survey	62	12.4%
Total	500	100.0%

5.3. Analysis of non-response bias

In order to establish the absence of non-response bias, it is desirable to gather survey data from a set of non-respondents and compare it to data supplied willingly. For a meaningful number of surveys and for all survey items, this method is rarely achievable.

A practical alternative, that has been argued to provide reliable results, is to compare the mean values of responses for earlier returns with the means from later returns [17]. This has been said to reveal any differences between early and late responders who required prompting. The assumption is that late responders share similarities with non-responders and, if no significant differences exist, the likelihood is strong that non-response bias does not exist [4]. For all of the constructs, tests were undertaken between first week respondents ($n = 25$) and those who responded after 6 weeks ($n = 27$). Differences between means of the two groups were not significant (two-tailed t-tests, $P < 0.05$) thus indicating that time had no apparent influence upon the perceptions and that non-response bias was unlikely.

5.4. Profile of respondents

Respondents were all CIOs from over 10 industry types as shown in (Table 3). The highest representation was from manufacturing, wholesale/retail, utilities/transportation, finance/insurance, computers/communication and publishing/news. Of the 161 companies, 50 reported annual revenues in excess of US$ 500 million. Respondents were well educated, with an average of 5 years college education. They had in excess of 17 years experience within their industry, 12 years experience within their company, and about 20 years within the field of IT. Thus, these CIOs were highly informed respondents.

Table 3
Responses by industry type(s)

Industry type(s)	Responses	Percent
Automobiles	9	5.6
Computers/communications	8	5.0
Finance/insurance	10	6.2
Health care/pharmaceuticals	4	2.5
Manufacturing	55	34.1
Oil/petroleum	4	2.5
Publishing/news	8	5.0
Restaurants/hotels	4	2.5
Utilities/transportation	22	13.7
Wholesale/retail	25	15.5
Other/undisclosed	13	8.0
Total	161	100.0

6. Results

Structural equation modeling (SEM), implemented through EQS, was selected as the analytical approach to data analysis. This approach, in which parameters are estimated by minimizing the discrepancy between the model implied covariance matrix and the observed covariance matrix, is commonly used in MIS research and has the advantages of using both measurement and structural models that are appropriate for measures with a strong theoretical foundation and supports statistical measurement of reliability and validity [25,40].

The maximum likelihood estimation (MLE) technique was used; this generates the smallest possible residual covariance matrix. Analysis followed the two-stage procedure suggested by Anderson and Gerbing in which a measurement model is estimated and refined and then a structural model with relational implications is tested [2].

6.1. Measurement modeling

Measurement modeling was performed using the six-model constructs comprising the 27 items. The objective was to refine the model data, maintaining the underlying theoretical assumptions, until an acceptable fit between study data and the hypothesized model was reached [41]. In the analysis it was unnecessary to drop any of the items or any of the observations from the analysis although three pairs of error terms were allowed to covary.

EQS provides results of the Lagrange multiplier (LM) test, which identifies possible paths or covariances that could be added to the model in order to improve overall fit. The LM test identified that three pairs of error terms, if allowed to covary, would improve model fit. These pairs were: PAR1 and PAR2; PAR4 and PAR5; and, ALN1 and ALN2.

The inter-item correlation for each of these pairs, shown in Appendix A, was very high ($r > 0.8$). PAR1 and PAR2 would be expected to covary because IT managers attending business planning meetings would be likely to lead to IT managers contributing to the formulation of business goals. PAR4 and PAR5 would be expected to covary because easy access to the CEO implies frequent contact with the CEO. ALN1 and ALN2 would be expected to covary, because IS plans that reflected the company's mission might also be expected to reflect its goals.

6.2. Model goodness-of-fit

There is no universally accepted indicator of goodness-of-fit, so it is customary to present several statistics as collective indicators. The χ^2 statistic is a fundamental measure but because it is sensitive to sample size "the researcher is encouraged to complement this measure with other measures of fit in all instances" [32]. The indicators chosen were ones used in prior MIS research. These were: the Non-Normed Fit Index (NNFI), the Comparative Fit Index (CFI), the Tucker–Lewis Index (TLI), the Root Mean Square-Error of Approximation (RMSEA), and the Root Mean Square Residual (RMR) [5]. The χ^2 statistic, also a measure of fit, is subject to distortion and is often replaced with the ratio of χ^2 to d.f. Indexes that exceed 0.90 are deemed acceptable for the NNFI, CFI, and TLI. Values of less than 0.06 for the RMSEA and less than 0.10 for the RMR are deemed acceptable. The preferred value for the χ^2/d.f. ratio is below 2 [10].

The probability for the χ^2 for the final measurement model was marginal ($P = 0.5$). However, all other goodness-of-fit measures for the final measurement model suggested a strong fit of the study data to the hypothesized model. Since the ratio of χ^2 to d.f. was very low (1.14), and all other indexes were well within the prescribed range, the results were accepted as supporting overall goodness-of-fit (Table 4).

Table 4
Goodness-of-fit for the final measurement model

Item	Suggested range	Measurement model value
χ^2	$P > 0.05$	$P = 0.05$
χ^2/d.f.	<2.00	1.14
Non-Normed Fit Index	>0.90	0.98
Comparative Fit Index	>0.90	0.98
Tucker–Lewis Index	>0.90	0.98
RMSEA	<0.06	0.03
RMR	<0.10	0.06

6.3. Construct reliability and validity

Table 5 presents standardized factor loadings and other metrics for each of the item measures as well as reliability and validity measures for the final measurement model. Nine of the 27 standardized factor loadings were below 0.7, indicating high error variance. It was decided to retain these items because of their theoretical value.

Several tests were performed to establish composite reliability, convergent validity, and discriminant validity. Composite reliability was established using two statistics that reflect the inter-item reliability of the construct items. The study values for Cronbach's α and composite reliability were all greater than 0.80, exceeding the recommended value of 0.70 [21,60].

A high level of convergent validity is desirable to ensure that items are measuring the same underlying phenomenon. In practice, this means that the indicators must be moderately or strongly correlated and have significant t-values. Convergent validity was established in two ways. First, the t-values for the factor loadings are all highly significant ($P < 0.01$). Second, convergent validity was established using the variance extracted test, which assesses the amount of variance explained by the underlying latent factor as compared to the amount ascribed to random measurement error [26]. The variance-extracted estimates revealed that five of the six constructs explain 50% or more of the variance. Together, these tests demonstrated the overall convergent validity.

Fifteen χ^2 difference tests were run to test for discriminant validity. For each pair of constructs, a constrained model was compared to an unconstrained model in order to determine whether the unconstrained model was significantly different. Fifteen constrained models were tested and the χ^2 difference calculated from the unconstrained model. The χ^2 differences are also χ^2 distributed with 1 d.f. Discriminant validity is established if the χ^2 statistic for the unconstrained model is significantly lower than for the constrained

Table 5
Measurement model results ($n = 161$)

Item	Mean	Variance	Standardized factor loading	t-value
Environmental uncertainty				
V1	4.54	1.65	0.73	9.7[a]
V2	4.60	1.58	0.79	10.7[a]
V3	4.23	1.75	0.82	11.2[a]
α/composite reliability = 0.82/0.82 variance extracted estimate = 0.61				
Information intensity				
V4	5.98	1.17	0.77	10.7[a]
V5	5.96	1.19	0.94	14.1[a]
V6	5.77	0.93	0.67	9.1[a]
V7	5.88	1.16	0.70	9.5[a]
α/composite reliability = 0.82/0.82 Variance Extracted estimate = 0.60				
Business Dependence on IT				
V8	6.22	0.89	0.63	8.6[a]
V9	6.38	0.91	0.82	12.1[a]
V10	6.09	1.06	0.89	13.5[a]
V11	5.91	1.18	0.63	8.3[a]
V12	5.94	1.06	0.74	10.3[a]
α/composite reliability = 0.87/0.90 variance extracted estimate = 0.56				
IT participation in business planning				
V13	4.73	2.00	0.81	11.1[a]
V14	4.65	1.92	0.86	12.4[a]
V15	5.87	1.20	0.76	10.4[a]
V16	5.51	1.61	0.62	8.0[a]
V17	4.89	1.83	0.69	9.2[a]
α/composite reliability = 0.89/0.87 variance extracted estimate = 0.57				
Alignment of IT plan with business plan				
V18	5.28	1.29	0.88	13.8[a]
V19	5.33	1.24	0.92	15.0[a]
V20	5.54	1.20	0.96	16.0[a]
V21	5.08	1.28	0.72	10.3[a]
V22	5.31	1.23	0.59	8.0[a]
α/composite reliability = 0.92/0.91 variance extracted estimate = 0.68				
Use of IT for competitive advantage				
V23	5.12	1.50	0.72	10.0[a]
V24	5.34	1.48	0.56	7.2[a]
V25	3.39	1.55	0.61	8.1[a]
V26	4.37	1.59	0.68	9.2[a]
V27	4.63	1.66	0.81	11.6[a]
α/composite reliability = 0.81/0.81 variance extracted estimate = 0.46				

[a] Indicates significance at $P < 0.0001$ or higher.

and the first model is accepted as being the preferred model. As shown in Appendix B, all of the χ^2 differences were significant ($P < 0.001$) suggesting strong properties of discriminant validity. Collectively, these tests were accepted as establishing the reliability and validity for the six-construct measurement model (Table 6).

6.4. Structural model

Results of the final measurement model were used to specify a structural model in which only the exogenous factors (or independent variables) are allowed to covary and theorized relationships are added by connecting the constructs with unidirectional paths,

Table 6
Goodness-of-fit for the structural model

Item	Suggested range	Measurement model value
χ^2	$P > 0.05$	$P = 0.014$
χ^2/d.f.	<2.00	1.19
Non-Normed Fit Index	>0.90	0.97
Comparative Fit Index	>0.90	0.97
Tucker–Lewis Index	>0.90	0.97
RMSEA	<0.06	0.03
RMR	<0.10	0.05

each of which represents the hypothesized association between the model constructs. Measurement of the strength and direction of these relationships is the focus of this confirmatory approach.

Again, the model was respecified until an acceptable fit was reached. All 27 variables and 161 observations were retained. Several error terms were allowed to covary; this implied that they were affected by a common influence not included in the model. The final model exhibited strong goodness-of-fit. The NNFI, CFI, and TLI all had values of 0.97; the RMSEA had a value of 0.03; the RMR had a value of 0.05; and, the ratio of χ^2 to d.f. was 1.19.

The path coefficients (with related t-values in parentheses) for the final structural model are presented in Fig. 3. All nine of the path coefficients were positive and significant indicating that the SEM analysis supported hypotheses H1–H3.

The disturbance term for the dependent variable was 0.7. This term reflects variability due, for example, to omitted variables, random shocks, and misspecification of equations. R^2, the percent of variability explained by the antecedent variables was calculated by subtracting the square of the term from one. Thus, about 52% of the variability in the dependent variable, $(1–0.7^2)$, was accounted for by the model.

6.5. ANOVA analysis for industry types

Standard one-way analysis of variance (ANOVA) was used to evaluate the relationships between the two contextual variables and the 10 industry types, as reported by the 161 respondents. Results of the ANOVA analyses, reported in (Table 7), show that the P-value for environmental uncertainty was significant ($\alpha = 0.05$) but the P-value for information intensity was not. The Levene statistic was not significant, indicating that data did not violate the homogeneity of variance assumption in either of the two cases.

The ANOVA rejected the null hypothesis, allowing us to accept H4. Separation of the means, to pinpoint where the differences for environmental uncertainty existed, was accomplished using the post hoc Tukey least significant difference (LSD) test. The mean values for environmental uncertainty by industry type

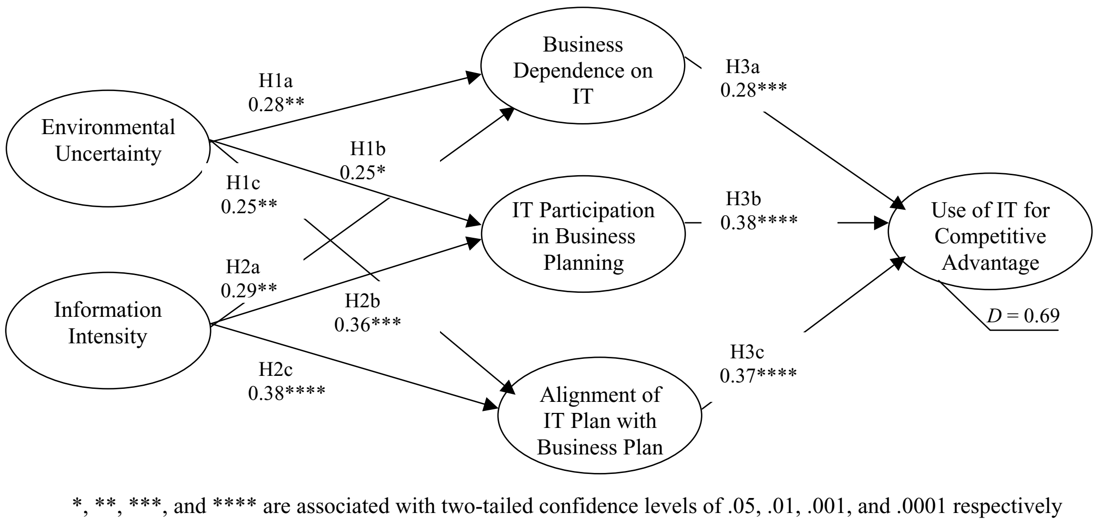

Fig. 3. Final structure equation model with path coefficients.

Table 7
Mean response for contextual variables by industry type(s)

Industry type(s)	Environmental uncertainty	Information intensity
Automobiles	3.70	5.81
Computers/communications	4.54	6.25
Finance/insurance	4.60	6.13
Health care/pharmaceuticals	5.25	6.56
Manufacturing	4.38	5.96
Oil/petroleum	2.75	5.88
Publishing/news	5.08	6.09
Restaurants/hotels	5.00	5.00
Utilities/transportation	3.98	5.88
Wholesale/retail	5.09	5.78
P-value	0.02	0.45
P-value significant	Yes	No
Levene statistic significance	0.78	0.21
LSD significant	Yes	NA

are presented in (Table 8) with the pairs of industry types for which the mean differences were significant ($\alpha = 0.05$). Of the 45 paired comparisons of industry types, there were 12 for which the mean differences were significant. Thus, we were able to conclude that environmental uncertainty varied significantly according to industry type and hypothesis H4 but not H5 was accepted.

7. Discussion

Our work indicated that: (1) there was a positive and significant association of environmental uncertainty and information intensity with business dependence on IT; (2) there was a positive and significant association of environmental uncertainty and information intensity with the two SISP constructs; and (3) there was a positive and significant association of business dependence on IT and the SISP practices with the use of IT for competitive advantage. Also, environmental uncertainty but not information intensity differed significantly for certain industry types.

7.1. Study contributions

Our research makes several useful theoretical and practical contributions. First, it supports the value of IT focus for information-intensive companies in an uncertain environment. Companies that had high information content in value chain activities and were subject to market pressures from product diversity had higher reliance on IT to support core activities and had adopted more formal methods of SISP. Thus, the focused use of IT is found to be contingent upon external factors.

Second, although management has consistently identified SISP as a critical issue, empirical research has not adequately addressed the external context in which management should use formal SISP practices. We have provided empirically validated evidence about these relationships. Overall, our hypotheses suggest that information intense firms in uncertain environments should invest in IT for the support of core activities and consider using formal IT planning methodologies to respond accurately to changes in external conditions.

Third, our work revealed a significant relationship between IT focus and the use of IT for competitive advantage. The companies that had invested highly in IT were more apt to have IT-based applications targeted at improving business level performance. Because a primary goal of SISP is to identify major IT investments, this indirectly supports the link between IT investments and business performance. It also refutes the notion that intuitive approaches to planning are more effective in mediating the effects of environmental uncertainty on technological based competitive advantage.

Fourth, study data helped dispel the debate surrounding failed IT investments. The relationships tell a story about companies that have invested in and become dependent upon IT and, as a result, have created applications directed at gaining a competitive advantage.

Fifth, we have addressed the influence of industry upon two important contextual variables. Tests found that, for all comparisons of industry data, no significant differences existed for the information intensity variable. For environmental uncertainty, however, 12 significant differences existed between industry types. Eight of the differences were between the oil/petroleum industry and other industry types. The oil/petroleum industry had a low mean value for the environmental uncertainty variable. However, the number of observations was 10 or less. Several significant mean differences, however, were between industry types for which a larger number ($n > 20$) of observations were available, namely between the

Table 8
Results of ANOVA between environmental uncertainty and industry types: means and significant differences

Industry type(s)	*n*	Auto-mobiles	Computers/communications	Finance/insurance	Health/pharmaceuticals	Manu-facturing	Oil/petroleum	Publishing/news	Restaurants/hotels	Utilities/transportation	Wholesale/retail
Automobiles	9	3.71[a]									
Computers/communications	8		4.54								
Finance/insurance	10			4.60							
Health Care/pharmaceuticals	4				5.25						
Manufacturing	55					4.38					
Oil/petroleum	4		b	b	b	b	2.75				
Publishing/news	8	b					b	5.08			
Restaurants/hotels	4						b		5.00		
Utilities/transportation	22						b			3.98	
Wholesale/retail	25	b				b	b			b	5.09

[a] Mean value for the environmental uncertainty variable.
[b] Industry types statistically different at the 0.05 level for the environmental uncertainty variable.

wholesale/retail industry and both manufacturing and utilities/transportation. Wholesale/retail exhibited a significantly higher level of environmental uncertainty in both instances.

7.2. Environmental uncertainty, information intensity and IT focus

Diversity in customer buying habits, product lines, and the nature of competition are positively associated with higher IT focus (i.e., dependence on IT, SISP practices). Also, dependence on accurate and timely information in production or service operations is positively associated with higher IT focus. These relationships were all positive and moderately strong revealing the importance of IT systems and SISP under these industry conditions.

A paramount finding was the study support for the nine relationships set forth in hypotheses H1–H3, which adds credence to the 'rational adaptive' theory that a combination of formal and informal IT planning methods will be successful in uncertain environments for information intense businesses. Under these circumstances, proactive efforts by the CIO and higher reliance on SISP approaches could be beneficial when balanced with participation and informal contacts with management. Conversely, positive and moderately strong path coefficients indicate that stable environments with lower information requirements are likely to exhibit lower reliance on IT focus. This may also explain why some poorly performing companies have heavily invested in information resources. Such investments may have been inappropriate for low levels of uncertainty and information intensity.

7.3. IT focus and the use of IT for competitive advantage

Study results show positive and highly significant associations between dependence on IT, IT participation in business planning, and the alignment of the IT plan with the business plan with the use of IT for competitive advantage. The model was successful in accounting for half of the variation in the dependent variable indicating that a rational adaptive IT planning approach, consisting of those measures used in this study, can positively influence the use of IT for competitive advantage under conditions of environmental uncertainty and information intensity.

7.4. Implications

The contingency relationships tested extend our understanding of the influence that investment in IT and SISP practices have on business performance under environmental uncertainty and information intensity. The results are replicable and can be extended by modifying or adding to the model constructs.

Past empirical research has had limited success in establishing a significant relationship between environmental uncertainty and SISP practices. This study firmly establishes a positive and significant relationship. Prior work has frequently failed to establish a relationship between strategic alignment and business performance, but we found a strong and significant relationship between strategic alignment and the use of IT for competitive advantage. Thus, our data presents a more positive case than previous findings for the efficacy of alignment.

Our data supported the notion of a relationship between industry type and environmental uncertainty but did not support a relationship between industry type and information intensity. MIS research supporting this relationship has been limited and results do not directly support a tie to MIS practices. The positive and significant relationship between environmental uncertainty and IT focus, however, implies that firms in certain industries are more apt to achieve IT focus and that their investment will be rewarded.

Finally, this study introduces the concept of IT focus, operationalized as business dependence on IT and the use of SISP practices. Past research has revealed an association between strategic IT practices and performance. However, the items used for the dependence on IT construct did not measure strategic practices but large, mission-critical systems that supported core activities. Such systems are not necessarily strategic and may be imitated by competitors. Our data indicate that an increased dependence on these systems was associated with an increased use of IT for competitive advantage, more so for information-intensive firms under environmental uncertainty.

Practitioners can benefit in several ways. CIOs and other IT managers can be assured that their proactive efforts can heighten the use of IT for competitive advantage in the presence of environmental uncertainty and information intensity. Specifically, by ensuring that mission-critical systems reflect changes in the environment, by aligning the IT mission, goals and strategies with those of the business plan, and by attending planning meetings and gaining access to top management.

CEOs and other management can benefit by ensuring that, under conditions of environmental uncertainty and information intensity, more emphasis is given to SISP practices. All managers will benefit by knowing the costs and time associated with these methodologies are wise investments. Managers and CIOs of information intense firms will also benefit by recognizing the importance of tracking environmental changes and carefully shaping SISP practices to support the complexity and uncertainty of the environment.

7.5. Study limitations

There were some study limitations. First, only one aspect of environmental uncertainty was explored. Second, generalizability of results may be limited due to the low survey response. Third, conclusions drawn from the data, while theoretically sound, are based upon the perceptions of a single informant. While CIOs are expected to be knowledgeable, study results would have been more reliable if paired with a second informant outside of the IT area. Although all responses were anonymous, it is still possible that the CIO responses are biased in favor of SISP benefits. Fourth, while findings support a significant and moderately strong relationship between both IT participation in business planning and IT plan-business plan alignment with the use of IT for competitive advantage, not all IT applications are the product of a formal SISP process. Enterprise level systems, including enterprise resource planning and customer relationship management systems, may be mandated by management and avoid a formal selection process. These systems also depend upon an extensive requirements analysis, implementation planning, and change management that are often beyond the scope of SISP.

Appendix A. Item correlation matrix for final structural model

		ENV1 V1	ENV2 V2	ENV3 V3	INT1 V4	INT2 V5	INT3 V6	INT4 V7	DEP1 V8	DEP2 V9	DEP3 V10	DEP4 V11	DEP5 V12	PAR1 V13	PAR2 V14	PAR3 V15	PAR4 V16	PAR5 V17	ALN1 V18	ALN2 V19	ALN3 V20	ALN4 V21	ALN5 V22	CA1 V23	CA2 V24	CA3 V25	CA4 V26	CA5 V27
ENV1	V1	1.00																										
ENV2	V2	0.51	1.00																									
ENV3	V3	0.52	0.63	1.00																								
INT1	V4	0.13	0.15	0.16	1.00																							
INT2	V5	0.15	0.18	0.18	0.74	1.00																						
INT3	V6	0.11	0.13	0.14	0.56	0.64	1.00																					
INT4	V7	0.11	0.14	0.14	0.73	0.67	0.51	1.00																				
DEP1	V8	0.13	0.15	0.16	0.16	0.18	0.15	0.15	1.00																			
DEP2	V9	0.20	0.22	0.23	0.23	0.26	0.20	0.21	0.59	1.00																		
DEP3	V10	0.21	0.25	0.26	0.26	0.30	0.23	0.24	0.51	0.73	1.00																	
DEP4	V11	0.14	0.17	0.17	0.18	0.20	0.15	0.16	0.50	0.49	0.56	1.00																
DEP5	V12	0.17	0.21	0.21	0.22	0.25	0.19	0.20	0.41	0.60	0.68	0.67	1.00															
PAR1	V13	0.18	0.21	0.22	0.27	0.31	0.23	0.25	0.10	0.14	0.16	0.11	0.13	1.00														
PAR2	V14	0.18	0.22	0.23	0.28	0.33	0.24	0.26	0.10	0.15	0.17	0.11	0.14	0.89	1.00													
PAR3	V15	0.17	0.20	0.21	0.26	0.29	0.22	0.23	0.09	0.13	0.15	0.10	0.12	0.61	0.64	1.00												
PAR4	V16	0.14	0.17	0.18	0.22	0.25	0.19	0.20	0.08	0.11	0.13	0.09	0.11	0.52	0.54	0.49	1.00											
PAR5	V17	0.16	0.19	0.19	0.24	0.28	0.21	0.22	0.09	0.12	0.14	0.10	0.12	0.57	0.60	0.54	0.82	1.00										
ALN1	V18	0.20	0.24	0.24	0.31	0.36	0.27	0.28	0.11	0.16	0.18	0.12	0.15	0.17	0.18	0.16	0.14	0.15	1.00									
ALN2	V19	0.21	0.25	0.25	0.33	0.38	0.28	0.30	0.12	0.17	0.19	0.13	0.16	0.18	0.19	0.17	0.15	0.16	0.93	1.00								
ALN3	V20	0.21	0.26	0.27	0.34	0.39	0.30	0.31	0.12	0.17	0.20	0.13	0.16	0.19	0.20	0.18	0.15	0.17	0.85	0.89	1.00							
ALN4	V21	0.16	0.19	0.20	0.25	0.29	0.22	0.23	0.09	0.13	0.15	0.10	0.12	0.14	0.15	0.13	0.11	0.13	0.63	0.66	0.69	1.00						
ALN5	V22	0.13	0.16	0.16	0.21	0.24	0.18	0.20	0.07	0.11	0.12	0.08	0.10	0.12	0.12	0.11	0.09	0.10	0.52	0.54	0.57	0.61	1.00					
CA1	V23	0.16	0.19	0.19	0.23	0.27	0.20	0.21	0.40	0.24	0.28	0.19	0.23	0.29	0.30	0.27	0.23	0.26	0.31	0.33	0.34	0.26	0.21	1.00				
CA2	V24	0.12	0.15	0.15	0.18	0.21	0.15	0.16	0.13	0.19	0.22	0.14	0.18	0.22	0.23	0.21	0.18	0.06	0.17	0.25	0.27	0.20	0.16	0.36	1.00			
CA3	V25	0.14	0.17	0.17	0.20	0.23	0.18	0.19	0.15	0.21	0.25	0.16	0.20	0.25	0.27	0.24	0.21	0.23	0.28	0.29	0.30	0.23	0.19	0.41	0.31	1.00		
CA4	V26	0.15	0.18	0.19	0.22	0.26	0.19	0.20	0.16	0.24	0.27	0.18	0.22	0.28	0.29	0.26	0.23	0.25	0.31	0.32	0.33	0.25	0.20	0.45	0.35	0.39	1.00	
CA5	V27	0.18	0.22	0.22	0.27	0.33	0.23	0.24	0.20	0.28	0.32	0.22	0.26	0.34	0.35	0.32	0.27	0.30	0.37	0.38	0.40	0.30	0.24	0.53	0.41	0.47	0.52	1.00

Appendix B. χ^2 difference tests for discriminant validity

Factors	χ^2 (d.f. = 302)	χ^2 difference	Significant at $P < 0.001$
F1/F2	489	147	Yes
F1/F3	481	139	Yes
F1/F4	482	140	Yes
F1/F5	484	142	Yes
F1/F6	470	128	Yes
F2/F3	484	142	Yes
F2/F4	471	129	Yes
F2/F5	485	143	Yes
F2/F6	446	104	Yes
F3/F4	474	132	Yes
F3/F5	534	192	Yes
F3/F6	471	129	Yes
F4/F5	444	102	Yes
F4/F6	417	75	Yes
F5/F6	465	123	Yes

Unconstrained model: $\chi^2 = 342$, d.f. = 301. The data given are for constrained model.

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